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FOOD HABITS OF THE PRAIRIE SPOTTED SKUNK IN SOUTHEASTERN IOWA

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The prairie spotted skunk, *Spilogale interrupta* (Rafinesque), is one of the more common mustelids in the state of Iowa. Because of its general distribution and its tendency to live about farm yards, as well as its omnivorous appetite, many queries, and not a few complaints, have been received by responsible agencies concerning the management of this animal. As the value of the prairie spotted skunk as a furbearer has been questionable, it is important that its worth be determined in other ways. An understanding of its relationship to economic species of insects, birds, and mammals is of fundamental importance in the process of formulating and putting into effect wise management practices for the species. For these reasons the following investigation was undertaken as part of an intensive study on the ecology and management of the species.

The area chosen for this investigation lies in the northeast corner of Van Buren County, near the southeast corner of the state (fig. 1). It consists of approximately 17.5 square miles. A diversified terrain was selected to obtain a more comprehensive study of the ecological requirements of the species. The western side of the area contains about seven square miles of rough, eroded woodland pasture largely of oak-hickory formation with several hundred acres cut over and grown up to hickory sprouts. This wooded area is interspersed with farms and clearings on the higher ground. The rougher western portion changes gradually to a flat plateau of about ten square miles almost entirely tiled for drainage and subjected to intensive agriculture. Corn, hogs, sheep, and hay are the principal products of the area. The soil on the eastern portion is the rich black Grundy silt loam characteristic of southern Iowa where erosion has not had its effects.

The investigation covered the period March 18, 1939, to March 1, 1940.

During this time seven months were spent in continuous residence on the area. When not in residence the author made trips at least twice a month with the exception of December, 1939, when only one visit was made.

This paper is based upon the analysis of 834 scats gathered during this period; 699 from within the bounds of the area, 135 from a place less than a mile and a half from its eastern border.

HISTORICAL REVIEW

Very little has been written concerning the food of the spotted skunk. Lantz (1923) says, "The little spotted skunks are remarkably efficient as

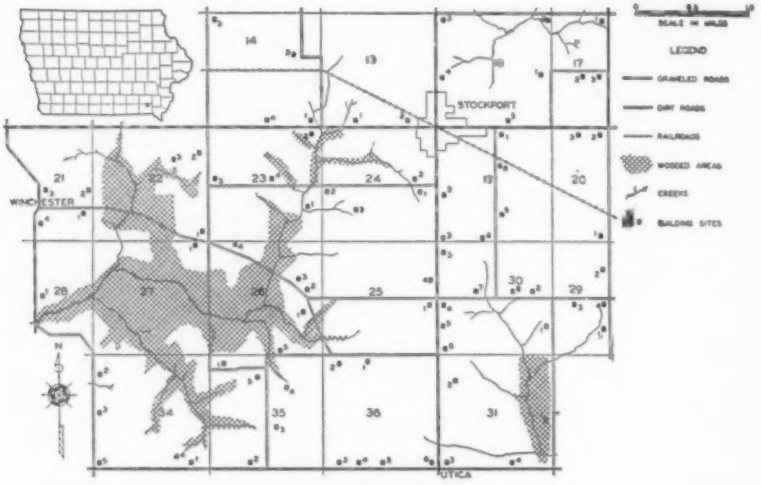

FIG. 1. Map of the area.

destroyers of rats and mice. They are small and nearly like a weasel in shape; they are quick in their movements, and can follow rats and mice into smaller crannies than the ordinary skunk can enter."

Howell (1906) states, "The food of the spotted skunks, judged by the records of 17 stomach examinations made by collectors of the Biological Survey, consists in large measure of insects, chiefly beetles and grasshoppers. These are supplemented by mice and other small mammals, lizards, salamanders, small birds, and crayfish. One stomach contained persimmons and several species of fungus."

Pellet (1913) writes as follows, "On one occasion rats became very troublesome under a big pile of cobs in one of the outbuildings. . . .Not long after, a small skunk took up its abode in the same building and the rats moved out with little delay. . . .They are expert in catching pocket gophers and I have

several times found them in the holes apparently in pursuit of the gopher. In winter they frequently catch rabbits."

Selko (1937) investigated 59 scats of the spotted skunk gathered in September, October, and November of 1936 in central and northwestern Iowa. He found insects and mammals sharing first place in importance. They appeared in 26 per cent of the feces. Mammal remains ranked second among the classes of food, appearing in 47 per cent of the feces but exceeded in volume by insects. Bird remains appeared in 16 scats or 27 per cent of the total. Vegetable matter appeared 16 times. Grass leaves, wheat kernels, horsenettle berries, oats, acorns, apple seeds, and two kernels of corn made up the list of items.

THE INVESTIGATION

Method of Procedure.—Scats were gathered at most of the locations used by the skunks at least every two or three weeks, depending somewhat upon the accessibility of the locality and the success in finding scats. During the time of residence on the area many places were visited regularly twice a week, but no place was visited oftener than every other day.

The feces of the spotted skunk are generally distinguishable by one feature or another. There were few striped skunks on the area and when there was any question as to species the scats were discarded. Size, form, contents, location, and odor all help to determine the species concerned (pl. 1-a). No single criterion was always an infallible indication of the species. One scat—unquestionably spotted skunk—found in the attic of a schoolhouse measured $\frac{11}{16}$ of an inch in diameter and $1\frac{1}{2}$ inches long. The scat contained insect remains and would have been questionable if found in the field. Most spotted skunk scats measure $\frac{1}{2}$ inch or less in diameter.

Spotted skunks appear to be much less inclined to making so-called "latrines" than are the striped skunks and as a rule they defecate promiscuously—often in their runways and in such inaccessible places as under buildings, in woodpiles or postpiles, and in strawpiles. As this study was primarily one of food habits every effort was made to avoid altering the natural situations of the animals or the forces shaping their environment. This often prevented obtaining inaccessible scats.

To facilitate a more accurate determination of the age of scats that were not strictly fresh, about two dozen fresh scats from a captive spotted skunk, which contained the remains of typical food items, as well as some scats that were found in the field, were exposed to the weather during May and June and checked daily. It was found that a scat retained its natural moisture about two days, and that the odor remained with a scat one to two weeks, depending on the contents. After two weeks there was no certain way to determine the age by the condition of the scat when picked up. It was found that scats well protected from the weather retained their odor longer and their shape almost

indefinitely. On the other hand, those that were exposed to rains, tramping of livestock, and other destructive factors deteriorated rapidly. A daily record of the weather was invaluable in estimating the age of scats in many instances (pl. 1-d).

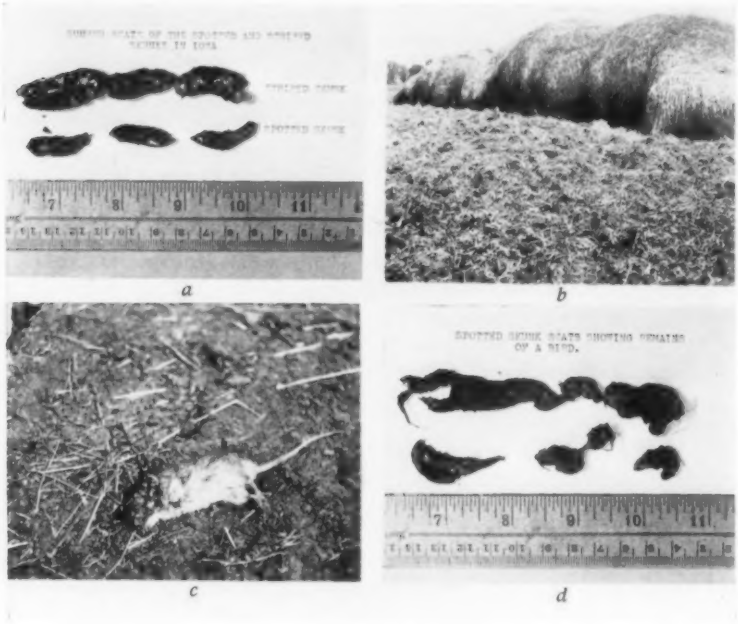

PLATE 1

(a) Spotted skunk scats compared with striped skunk scats.

(b) The thorough uprooting of a rotting strawpile by the spotted skunks in search of the larvae of the scarab, *Osmoderma eremicola*. This is evidence of several nights' work. July 12, 1939.

(c) Rat killed in a horse barn manger at Stockport by a spotted skunk, but not eaten. Notice the mutilation of the head and neck. April 7, 1939.

(d) Typical scats of the spotted skunk after eating a bird.

Each scat found was placed in a separate paper sack, plainly marked with the time and place of acquisition and its probable date of deposition.

No scats were used in this study that could possibly be over one month old. Many scats were discarded because of indefinite age such as those found in haybarn runways when the hay was removed in early spring. The scats were analysed dry. The identifications were made by comparison with a large collection of known foods from the area and by comparison with the collec-

tion of insects, seeds, mammals, and birds kept at the laboratory for that purpose.

Quite a wide variation exists between the number of scats gathered during the winter months and the other three seasons; hence, it was decided to consider the food habits data by seasons. The seasons were arbitrarily divided into units of three months each: (1) winter period—December, January, and February, (2) spring period—March, April, and May, (3) summer period —June, July, and August, and (4) fall period—September, October, and November.

Winter foods.—Mammals were the most important winter food; 90.44 per cent of all the scats contained the remains of one or more species in this group. Mearns cottontail rabbits (*Sylvilagus floridanus mearnsii*) were the most important single item. Their remains occurred in 38 of 75 scats (50.54 per cent). They also represented 54.26 per cent of all mammals. There was a heavy population of cottontails on the area during 1938 and 1939. In the winter of 1939–40 when these scats were gathered, cottontails were so numerous that they did extensive damage to shrubs and fruit trees. Large numbers were shot by farmers all over the area as a protective measure. Most of these rabbits were left where they fell and with little spoilage during the cold weather they were almost continually available as carrion to the spotted skunks and other scavengers (pl. 2-d).

Meadow mice (*Microtus pennsylvanicus*, and *M. ochrogaster*) were the next in importance. This genus appeared in 18.62 per cent of all scats and represented 19.92 per cent of all mammals appearing during this period (pl. 2-b).

Norway rats (*Rattus norvegicus*) were third in importance among the mammals. They were found in 9.31 per cent of the scats during this period and made up 10 per cent of the mammalian occurrences. The spotted skunks' predation on rats in winter about farm buildings was very noticeable. It was observed at several places on the area that a heavy population of rats during the summer and fall completely disappeared, or nearly so, during the winter months when a spotted skunk was in residence. Whether the skunks killed more than they drove away is a question, but, nevertheless, they appeared to exercise a controlling influence on the rats.

Other mammals appearing in 5 per cent or less of the scats were: white-footed mice (*Peromyscus* sp.); prairie harvest mice (*Reithrodontomys megalotis dychei*), and house mice (*Mus musculus*). Mice of undetermined species appeared in 3.99 per cent of the scats.

The next important group of items was plant material in which corn (*Zea mays*) took a dominant position. It exceeded all other single items except cottontail. It appeared 19 times (25.27 per cent) and represented 70.3 per cent of all vegetable matter. Many spotted skunks lived about buildings, frequently under and in corn cribs, and while taking their regular toll on the rat and mouse population they also utilized the corn. They apparently ate

PLATE 2

(a) Cottontail carrion partly eaten by the spotted skunk. This rabbit was entirely eaten the next night. March 28, 1939.

(b) A typical winter sight. The scat (lower right) was pried up from the depression melted under it in the snow so that it would show in the photograph. Meadow mice were caught by spotted skunks in such places as this.

(c) An illustration of the digging at the roots of greater ragweeds for insects on the Stockport area. Fresh scats were picked up within two feet of these two plants. June 14, 1939.

(d) A few of the cottontails shot by farmers during February of 1940 on the area. Notice the rabbit damage to the shrubbery. Cottontails such as these were available to scavangers, including the spotted skunk, during most of the winter.

it many times in preference to other foods. Two or three of the animals deposited scats consisting almost entirely of corn in the traps when they were caught for tagging purposes.

Insects appeared in 14.63 per cent of the scats gathered during this period. This is significant in view of the fact that few appeared to be available. Dearborn (1932) says that the striped skunks in Michigan continue to find insects as long as the ground remains uncovered with snow. This observation seems to apply equally as well to the spotted skunks for traces of Hemiptera, Coleoptera, Orthoptera, and Lepidoptera appear from one to four times each in the scats (see table 1 and figs. 2 and 3).

Birds consistently appeared in the scats. Bird remains were in 5.32 per cent of the winter scats. Pigeon (*Columba livia*) appeared twice, domestic chicken 3 times, and an unidentified small bird once. The chicken in this case was known to be carrion. All three scats containing chicken were from the same skunk during one week in January (figs. 2 and 3).

Spring foods.—Mammals were the most important spring food taken. Mammal remains appeared in 86.35 per cent of the scats. Field mice came into prominence in this season. Meadow mice were the most important and appeared in 36.66 per cent of the scats. They represented 34.96 per cent of all mammalian occurrences. White-footed mice appeared in 20.3 per cent of the scats and represented 19.36 per cent of the mammalian occurrences. These mice became more accessible during the spring months when the snow was off the ground. Other foods being relatively more difficult to procure, the spotted skunks probably range farther afield during this season in search of food.

Mearns cottontail was still an important item in the diet. Cottontails appeared in 17.87 per cent of the scats and represented 17.05 per cent of the mammalian occurrences. These scats were gathered in 1939 after a heavy population of rabbits had wintered over. During the spring months many adult cottontails succumbed to natural causes and dead ones could be found in almost every weed patch or brush pile. Since other foods were more abundant then than in the winter, fewer rabbits were utilized than might otherwise have been the case. The rabbits appearing in the scats were probably all carrion. No evidence was found of predation on adult cottontails by the spotted skunks (pl. 2-a).

Other mammals appearing in the feces during this period and the per cent of scats containing them are as follows: House mouse, 6.36; Norway rat, 6.06; harvest mouse, 1.81; and little short-tailed shrew (*Cryptotis parva*), 3.33. Unidentified mice appeared in 11.81 per cent of the scats. The spotted skunks continued to prey upon rats during this period but when other foods, which were probably more palatable, were available they only killed the rats and did not make a practice of eating them (pl. 1-c).

The next important group of items was the arthropods; 47.57 per cent of the scats contained their remains. Arthropods were represented in a few more than one half of the number of scats containing mammal remains. Insects and insect larvae appeared in 37.87 per cent of the scats. Most prominent

TABLE 1.—*Food of the spotted skunk in Iowa*

FOOD ITEMS	WINTER—75 SCATS			SPRING—330 SCATS			SUMMER—254 SCATS			FALL—185 SCATS		
	Appearances		Per cent of total scats appeared in	Appearances		Per cent of total scats appeared in	Appearances		Per cent of total scats appeared in	Appearances		Per cent of total scats appeared in
	No.	Per cent		No.	Per cent		No.	Per cent		No.	Per cent	
Mammals												
Microtus spp.	14	19.92	18.62	121	34.96	36.66	20	20.00	7.86	47	34.02	26.50
Peromyscus spp.	4	5.71	5.32	67	19.36	20.30	11	11.00	4.32	6	4.34	3.38
Reithrodontomys megalotis dychei	1	1.42	1.33	6	1.73	1.81						
Mus musculus	3	4.28	3.99	21	6.06	6.36	4	4.00	1.57	6	11.58	3.38
Unidentified mice	3	4.28	3.99	39	11.27	11.81	38	38.00	19.93	41	29.68	23.12
Rattus norvegicus	7	9.99	9.31	20	5.78	6.06				5	3.62	2.82
Sylvilagus floridanus mearnsii	38	54.26	50.54	59	17.05	17.87	27	27.00	10.61	22	15.92	12.40
Cryptotis parva				11	3.17	3.33						
Ovis aries				2	.57	.60				1	.72	.56
		100.00			100.00			100.00			100.00	
Birds												
Columba livia	2	33.20	2.66	4	19.04	1.21	3	11.40	1.17			
Gallus gallus	3	49.80	3.99	3	14.28	.90	3	11.40	1.17			
Colaptes auratus				1	4.76	.30						
Gallus gallus eggs				1	4.76	.30				1	14.28	.56
Unidentified small birds' eggs				3	14.28	.90	5	19.00	1.96			
Sturnella magna eggs							1	3.80	.39			
Colinus virginianus eggs							1	3.80	.39	1	14.28	.56
Sturnella magna							5	19.00	1.96			
Turdus migratorius							2	7.60	.78			
Zenaidura macroura							1	3.80	.39			
Unidentified small birds	1	16.60	1.33	9	43.84	2.72	5	19.00	1.96	5	71.40	2.82
		100.00			100.00			100.00			100.00	

Plant Material												
Zea mays	19	70.30	25.27	20	51.20	6.06	2	2.98	.78	29	31.61	16.35
Avena sativa	3	11.10	3.99	8	20.48	2.42	2	2.98	.78	1	1.09	.56
Vitis spp.	1	3.70	1.33				3	4.47	1.17	20	21.80	11.28
Setaria spp.	2	7.40	2.66	1	2.56	.30				3	3.27	1.69
Grass	2	7.40	2.66	9	23.04	2.72	7	10.43	2.75	7	7.63	3.94
Abutilon spp.				1	2.56	.30						
Morus rubra							47	70.03	18.47	1	1.09	.56
Solanum nigrum							1	1.49	.39			
Physalis spp.							1	1.49	.39	24	26.16	13.35
Ambrosia spp.							1	1.49	.39			
Ribes spp.							1	1.49	.39			
Prunus serotina							1	1.49	.39	2	2.18	1.12
Malus spp.										1	1.09	.56
Unidentified seed							1	1.49	.39	2	2.18	1.12
					100.00			100.00			100.00	
Arthropods												
Millipeds												
Parajulus spp.	1		1.33	85		25.75	8		3.14	24		13 53
Insects												
Locustidae	4	33.32	5.32	15	8.61	4.54	16	2.73	6.28	102	39.16	57.52
Gryllidae							88	15.04	34.58	14	5.37	7.89
Coreidae	2	16.66	2.66	3	1.72	.90	4	.68	1.57	9	3.45	5.07
Pentatomidae										1	.38	.56
Hemiptera (other than above)	2	16.66	2.66	1	.57	.30						
Cicindelidae							9	1.53	3.53	3	1.15	1.69
Scarites spp.				14	8.03	4.20	57	9.74	22.40	3	1.15	1.69
Harpalus spp.				17	9.75	5.15	118	20.17	46.37	21	8.06	11.84
Calosoma spp.				1	.57	.30	5	.85	1.96			
Chlaenius spp.							2	.34	.78			
Evarthus spp.							4	.68	1.57			
Carabidae (other than above)				28	16.07	8.48	41	7.01	16.11	26	8.96	14.66
Macrobasis spp.				1	.57	.30						
Silpha spp.				4	2.29	1.21	2	.34	.78			
Necrophorus spp.				9	5.16	2.72	6	1.02	2.35	2	.76	1.12

TABLE 1.—*Concluded*

FOOD ITEMS	WINTER—75 SCATS			SPRING—330 SCATS			SUMMER—254 SCATS			FALL—185 SCATS		
	Appearances		Per cent of total scats appeared in	Appearances		Per cent of total scats appeared in	Appearances		Per cent of total scats appeared in	Appearances		Per cent of total scats appeared in
	No.	Per cent		No.	Per cent		No.	Per cent		No.	Per cent	
Arthropods, insects—*Concluded*												
Pelidnota spp.							3	.51	1.17			
Canthon spp.							3	.51	1.17			
Euphoria spp.							1	.17	.39			
Osmoderma eremicola larvae							4	.68	1.57			
Phyllophaga and *Ligyrus* spp.				34	19.51	10.30	82	14.02	32.22	28	10.75	15.79
Phyllophaga larvae							1	.17	.39	1	.38	.56
Aphodius spp.										10	3.84	5.64
Scarabacidae (other than above)				2	1.14	.60	5	.85	1.96			
Meloidae							2	.34	.78			
Lucanus dama							1	.17	.39			
Tenebrionidae							1	.17	.39			
Chrysomelidae							2	.34	.78			
Curculionidae							1	.17	.39	3	1.15	1.69
Elateridae				1	.57	.30				1	.38	.56
Coccinellidae										1	.38	.56
Ptinidae				1	.57	.30						
Coleoptera (other than above)	1	8.33	1.33	11	6.31	3.33						
Formicidae							6	1.02	2.35	3	1.15	1.69
Vespidae				1	.57	.30	1	.17	.39			
Polistes spp.							2	.34	.78			
Sphecidae							1	.17	.39			
Diptera										1	.38	.56
Lepidoptera larvae							25	4.27	9.82	4	1.53	2.25
Lepidoptera (other than above)	1	8.33	1.33									
Unidentified insect parts	2	16.66	2.66	31	17.79	9.39	81	13.85	31.83	28	10.75	15.79
		100.00			100.00			100.00			100.00	

were various species of carabids which represented 34.42 per cent of the total insects eaten. Next in importance were the various species of May beetles

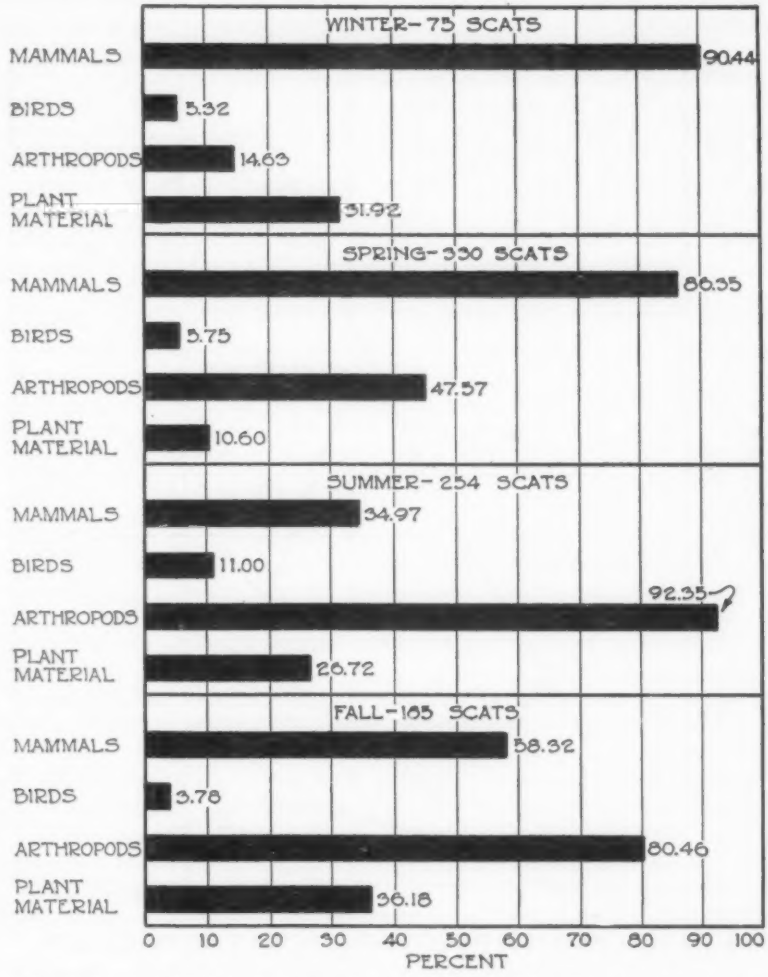

FIG. 2. Spotted skunk food. Percentage of scats in which various items appeared.

(*Phyllophaga* spp.) which appeared in 10.3 per cent of the scats and represented 19.51 per cent of all the insects present.

Millipeds (*Parajulus* spp.) appeared in 25.75 per cent of the scats. They were abundant about strawpiles and weedy fence rows during this period and the skunks seemed to relish them. Occasionally, a scat appeared that contained nothing but milliped remains. The greatest number appearing in any

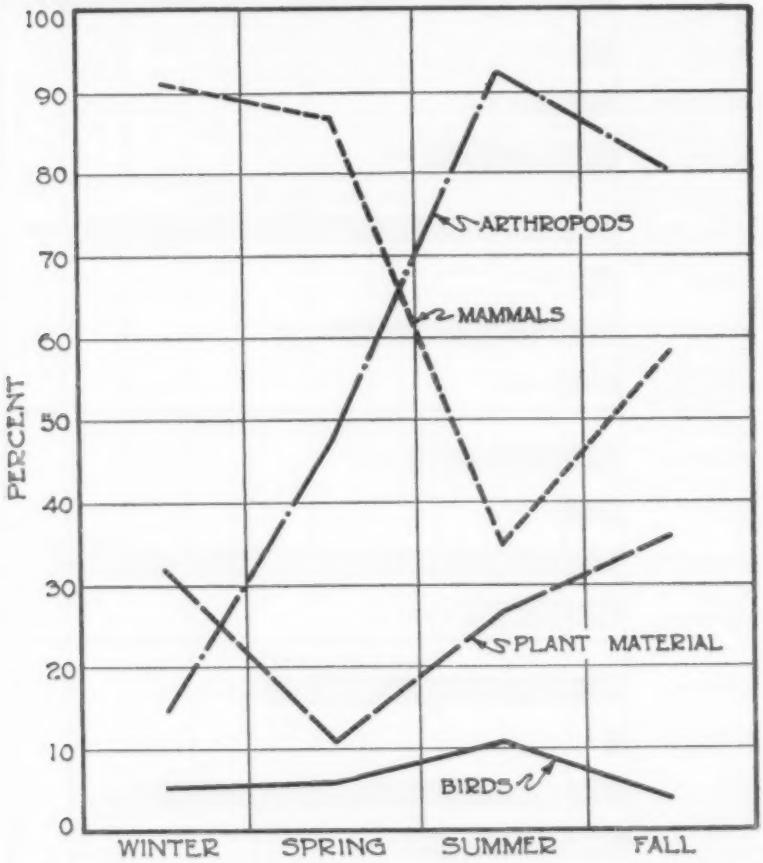

FIG. 3. Percentage of scats in which various items of food appeared by seasons.

one scat was ten. Usually a scat containing millipeds also contained considerable soil ingested with the food.

Plant material appeared in 10.60 per cent of the scats. Corn again was most important, representing 51.20 per cent of the vegetable matter. Oats (*Avena sativa*) and grass represented 20.48 and 23.04 per cent respectively. Grass was probably ingested accidentally many times but the large amount

appearing would indicate that the animal, like the domestic cat, may at times purposefully eat grass. Oats, however, were sometimes taken intentionally for one scat in March contained 9 cc of them. Oats may be used as a "stuffing food" at times.

Birds and birds' eggs represent the smallest percentage in appearances (3.81 per cent of the total). Feathers of small birds appeared 9 times or in 2.72 per cent of the scats. Pigeon appeared 4 times, flicker (*Colaptes* sp.) once, and domestic chicken 3 times. Small birds' eggs appeared 3 times, and hens' eggs once (figs. 2 and 3).

Summer foods.—Arthropods were the most important summer food as 92.35 per cent of the scats gathered during this period contained them. Millipeds appeared only 8 times. The other arthropods were insects. Here again the carabid beetles led, with the genera *Harpalus* and *Scarites* particularly numerous. *Harpalus* appeared in 46.37 per cent of the scats and represented 20.17 per cent of all insects; *Scarites* appeared in 22.40 per cent of the scats and represented 9.74 per cent of all insects. May beetles and larvae were second in appearances with 32.61 per cent of the scats containing them. A large number of these beetles, especially May beetles, were dug up at the roots of greater ragweeds (*Ambrosia trifida*) during June. The spotted skunks dug a shallow hole about two inches deep following the tap root. In one night they would systematically go to almost every plant, in a patch of 200 or 300 plants, and dig at the roots for these insects. They seldom captured all of them under a weed for when these same weeds were pulled up the next morning other beetles could be obtained. This type of activity was not observed during July and August but it appeared again in the fall (pl. 2-c).

For several days during early July spotted skunks on the area dug up a great many larvae of the scarab, (*Osmoderma eremicola*) a large white grub found in rotting strawpiles at that time. Their industry in pursuit of this grub was demonstrated several places where a thousand square feet or more of surface would be stirred up to a depth of about three inches as though a man had done it with a fork (pl. 1-b). At one place on the area it was found that striped skunks (*Mephitis mephitis avia*) had been just as assiduous in the search for these grubs as had spotted skunks.

Mammals were found in 34.97 per cent of the summer scats. The various species of mice made up 73 per cent of all mammal remains. Meadow mice led again, representing 20 per cent of all mice taken. Norway rats did not appear during this season. Several observations were made of spotted skunks living apparently amicably side by side with Norway rats during this period; frequently under the same buildings and woodpiles.

Plant material appeared in 26.72 per cent of the scats with mulberries (*Morus rubra*) appearing in 18.47 per cent of the scats and representing 70.03 per cent of all plant material. Mulberries were particularly abundant during June. Large numbers of ripe berries fell to the ground under the trees that were numerous and well distributed over the area.

The number of birds appearing during this period was significant yet made up but a small percentage of the total food. Birds and birds' eggs were found in 11 per cent of the summer scats. In June one scat contained the breast feathers and egg shell of a meadowlark (*Sturnella magna*). Meadowlark feathers appeared 5 times and represented 19 per cent of the total birds. Bobwhite (*Colinus virginianus*) eggs appeared once. Other birds taken were: barn pigeon, 3; chicken, 3; robin (*Turdus migratorius*), 2; mourning dove (*Zenaidura macroura*), 1; unidentified birds, 5; unidentified small birds' eggs, 5 (figs. 2 and 3).

Fall foods.—Arthropods dominated; they appeared in 80.46 per cent of the scats. Millipeds were numerous, occurring in 13.53 per cent of the scats; however, the bulk of this group, 47.51 per cent, was insects. The most important insects were members of the family Locustidae; *Melanoplus femur rubrum* and *M. differentialis* were the two most common species taken. Members of this family appeared in 57.52 per cent of the scats during this period, and represented 39.16 per cent of all insects taken. May beetles were of next importance, constituting 10.75 per cent of all insects. The various species of carabids were important; members of the genus *Harpalus* were found in 8.06 per cent of all scats containing insects.

Mammals came into prominence again. They were found in 58.32 per cent of the scats. Meadow mice were most important, representing 34.02 per cent of the mammals taken. Norway rats again began to show up; they accounted for 3.62 per cent of the mammals. Cottontail rabbits were again frequently found in the scats, representing 15.92 per cent. Vegetable matter, especially fruit, was common in the early fall diet. Later in the fall much corn was taken and consequently it outranked the individual fruits in appearances, for 31.61 per cent of the vegetable matter appearing was corn. Ground cherries (*Physalis* sp.) represented 26.16 per cent and grapes (*Vitis* sp.) 21.80 per cent of vegetable frequencies. To procure the grapes it was apparently necessary for one of the skunks to climb up a brace post in a fence corner and take them off the vine. A few mulberries were still available in the early fall and were utilized. Wild black cherries (*Prunus serotina*) were numerous on the area but little used by the skunks. They appeared only twice in the feces.

Fewer birds were taken in this period as compared with the other three seasons. Only 3.78 per cent of the scats contained bird remains. Unidentified small birds appeared 5 times, chicken eggs once, and bobwhite eggs once. The bobwhite egg may have been left over from the nesting season (figs. 2 and 3).

SUMMARY

1. The research into the food habits of the spotted skunk covered a 12 months period, March 18, 1939, to March 1, 1940. The investigation was confined to an area of 17.5 square miles in southeastern Iowa.

2. Seven months were spent in continuous residence in the field. During the other 5 months trips were made to the area twice a month for the purpose of gathering scats (with the exception of December when only one trip was made). The collection totaled 834 scats.

3. The scats were grouped arbitrarily into seasonal periods: winter, spring, summer, and fall.

4. Winter foods were largely of mammal origin. Cottontail rabbit appeared most frequently. It was found in 54.26 per cent of 75 winter scats. Corn was an important item during this season, appearing in 25.75 per cent of the scats.

5. Spring food was predominantly mammals. Native field mice were most common and appeared in approximately 80 per cent of 330 spring scats. Insects also appeared frequently and were found in 47.57 per cent of the scats during this period.

6. Summer food was predominantly insects; they were found in 92.35 per cent of 254 scats. Mammals appeared in only 34.97 per cent of the scats. Plant material (mostly fruit) appeared in 26.72 per cent of the scats, while birds and birds' eggs were found in 11 per cent. Birds were eaten more frequently during this period than at any other time.

7. Fall food, like summer food, was predominantly insects; 80.46 per cent of 185 scats contained them. Mammals were also important in this season, appearing in 58.32 per cent of the scats. Fruits such as grapes, mulberries and ground cherries appeared in 36.18 per cent, while birds were found in only 3.78 per cent. Fewer birds appeared during this period than at any other time.

8. The spotted skunk is an omnivorous animal. During this investigation insects seemed to be the preferred food with members of the families Carabidae and Scarabaeidae being taken most frequently. Small mammals were a regular and important item in the diet. Norway rats were eaten freely when other food was difficult to obtain. Cottontail carrion and chicken carrion were taken freely during the winter when they were available. Birds appeared infrequently in the diet, probably because they are more or less unavailable, although they were readily utilized when possible. Grain, such as corn, was eaten frequently when other foods were more difficult to procure. Fruits were taken readily when available.

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TRAPPERS AND FUR ANIMALS OF THE ORIGINAL DELTA REGION OF MISSISSIPPI

BY LEE E. YEAGER

In a former paper (Yeager, 1938), I presented an account of the otters of the Delta region of Mississippi, based mainly on records secured from old Delta hunters and trappers. Recently I had the opportunity to add to these records and, in addition, to secure or verify information on other Delta fur animals. This material has been checked until I have satisfied myself of its reliability and is presented below.

For the greater part of this account I am indebted to T. E. Cockrell of Indianola and J. J. Cockrell and W. S. Cockrell of Itta Bena, all of Mississippi. All are members of my immediate family whose experience with Delta mammals covers the period from 1860 to date, of which nearly 50 winters were spent in Delta hunting and trapping camps. My own experience includes 26 years of residence and since 1933 seven years of fairly close association. Perhaps a score of others, mostly old-time trappers and woodsmen, have contributed to the general information given here.

Haddon (1903), King (1932), and Leopold (1937) have ably discussed the need of preserving vanishing biological data. I firmly believe that the older trappers of the region under discussion, and elsewhere, hold a great store of information yet unrecorded, which is rapidly being lost. As examples, T. E. Cockrell, in 1908–09, caught 155 raccoons in two weeks, 355 during the season; in 1910 he shot four otters while inside their den. One purpose of this paper is frankly to present certain reliable data of this sort in the hope that others closer to more extensive information may fill in the gaps before this opportunity is altogether removed.

In this paper "original" does not refer especially to the era of discovery and early settlement; it is concerned most with that period immediately preceding the greatest timber clearing era in the Delta, beginning about 1890 and ending about 1915. Over large areas of the Delta, this was still the time of virgin forests and original or nearly original fauna.

THE DELTA REGION

The Delta, as considered here, is that region of alluvial bottomland laid down by flood waters of the Mississippi and Yazoo rivers in northwestern Mississippi between Vicksburg and the Tennessee line (Fig. 1). It comprises more than 10 counties, or roughly one-seventh of the state. This flood plain of 8,000 square miles was originally covered by heavy hardwood and cypress forests broken by lakes, swamps, and southerly-flowing streams. It is commonly referred to as the Yazoo-Mississippi flood plain or the Mississippi River bottomland; locally, simply as the "Delta." In topography, waterways, timber types, and fauna this region was, and still is, similar to the remainder of the Mississippi flood plain extending from southern Missouri into southern Louisiana.

The developmental history of the Delta can be summarized by stating that during the last half-century the wilderness has been turned into one of the greatest cotton producing centers in the South. There still exists in a number of counties a considerable area of forest land, however. But even here, notwithstanding comparative intactness of the original cover, a great change has occurred in the mammalian fauna, due chiefly to hunting, trapping, fire, and water pollution.

ORIGINAL DELTA HABITATS OF FUR ANIMALS

In the original wilderness and even after the beginning of settlement, Delta fur animals seem to have occupied rather definite habitats. Broadly speaking, the entire region was made up of two main habitat types: (1) the hardwood ridges and flats, (2) and the permanent water areas—lakes, streams, and swamps—bordered or covered by heavy cypress and tupelo gum timber.

The lower portions of the hardwood ridge type were known as the "flat-

woods," and were wet, level, and often comparatively large timbered areas supporting several species of lowland white and red oaks (*Quercus* spp.), elms (*Ulmus* spp.), maples (*Acer* spp.), water hickory (*Hicoria aquatica*), pecan (*Hicoria pecan*), white ash (*Fraxinus americana*), hackberry (*Celtis laevigata*), persimmon (*Diospyros virginiana*), pawpaw (*Asimina triloba*), and hawthorn (*Crataegus* sp.). The soil is tight clay, decidedly moist, and often flooded during the late fall, winter, and spring. The ridges are better drained

FIG. 1. The Delta Region of Mississippi.

and of exceedingly fertile black loam. Here, red gum (*Liquidamber styraciflua*), southern red oak (*Quercus rubra*), white oak (*Quercus alba*), American holly (*Ilex opaca*), black gum (*Nyssa sylvatica*), flowering dogwood (*Cornus florida*), blue beech (*Carpinus caroliniana*), white ash, and several species of hickories (*Hicoria* spp.) were the principal trees. Grapes and muscadines (*Vitis* spp.) were abundant, the vines of the former often reaching a diameter of eight inches.

Hardwood flats, especially those bordering water, were preferred by raccoons. The largest one-season catch of raccoons of which I have record was made in the "flatwoods" type. According to old trappers, wildcats (probably *Lynx rufus floridanus* Rafinesque) also preferred the hardwood ridges and flats. They are said to have been most frequently trapped along ridge and flat margins on logs that led out into swamps or water.

Aquatic habitats, whether stream, bayou, lake, or swamp, were characterized by dense cypress (*Taxodium distichum*) and tupelo gum (*Nyssa aquatica*) usually of large size. Cypress knees grew everywhere and ranged in height from a few inches to 10 feet or more. Water elm (*Planera aquatica*), swamp privet (*Forestiera acuminata*), buttonwood (*Cephalanthus occidentalis*), water locust (*Gleditsia aquatica*), and willow (chiefly *Salix nigra*) were all common. On the higher banks of streams and lakes grapes and muscadines grew in profusion and elderberry (*Sambucus canadensis*), greenbriars (*Smilax* spp.), and blackberries (*Rubus* spp.) were often on the same site. Southern cane (*Arundinaria macrosperma*), forming cane brakes, bordered or extended out from many of the swamps and low-banked lakes and streams. Cane occurred abundantly in both "switch" and fishing-pole sizes and the former was considered an important winter food of southern white-tailed deer.

Minks and otters were the most characteristic fur species of the aquatic habitats. Minks showed some preference for creeks and smaller runs; otters a clear preference for large, deep-water swamps and log-filled, heavily timbered, and shaded lakes. Further discussion of the original otter habitat will be given in the next section of this paper, and additional details on all species will be found under the heading FUR CATCH AND VALUE.

Opossums, from the fur standpoint, were of little interest to Delta trappers until about 1910, and perhaps for this reason many trappers were vague concerning their preferred habitat, if indeed they had any. The information that I have seems to indicate that opossums were about equally abundant over the ridge, flat, shallow swamp, and water-edge types. Naturally, they did not occur in their greatest numbers in the larger, deep-water swamps. Early trappers took opossums only when they fell into log and bait sets made for minks and raccoons, which were most frequently placed in the vicinity of water. A number of trappers agreed that opossums favored log over tree dens, which, if true, was probably because of the easier accessibility of log retreats. Ground dens, because of the high water table, seem seldom to have been used in the Delta by opossums or other fur animals.

The day of beaver had largely passed by 1900. My grandfather, J. J. Cockrell, states that they commonly dammed small creeks and outlets to cypress-tupelo gum brakes. Bank dens were exceptional due to the low, swampy nature of the stream and lake margins.

The Delta seemingly has never been inhabited, unless recently, by muskrats, skunks, and foxes, except along the eastern and southern borders. Although I

have never secured a Delta record for any of these three species, I was recently told that a few gray foxes now occur in Sunflower County, near the heart of the Delta country.

It should be understood that a great deal of overlap occurred in the original habitats of Delta fur animals. This was certainly true of raccoons and opossums, and to a greater or less extent for all species, including otter. T. E. Cockrell told me that a trapper operating entirely in the "flatwoods," even along water, would likely catch 10 raccoons to one mink; if working entirely in cypress-tupelo gum swamps, minks would probably outnumber raccoons by about three to one. This indicates a distinctly more adaptable nature in raccoons in a completely timbered habitat; minks were most dependent on water.

OTTER DENS AND HUNTING METHODS

T. E. and W. S. Cockrell have jointly given me the best description of an otter den and the best account of early otter hunting and trapping methods that I have secured. These accounts are in addition to those given in the paper cited at the beginning of this article.

This otter den was in Fowl Brake, Leflore County, Mississippi, and was discovered by the Cockrell brothers one morning in December, 1910. It was in the hollow base of a huge, overmature cypress, which stood at the edge of the water, low at that season. It was deep in the swamp, surrounded by a heavy stand of cypress and tupelo gum timber. The brothers found the den by following a well-defined otter trail that they happened to cross in setting a trapline. The trail led into a large hollow root, exposed by low water, and showed that four otters had entered the den tree. Against the nine-foot cypress a dead tupelo gum had lodged in such position that the top of this log was about six feet above the ground. As it was nearly noon, the brothers plugged the hollow root, hurried to camp for lunch and axes, and returned to the den early in the afternoon.

Chopping while standing on the fallen gum, one of the brothers found that the cypress was little more than a shell at about 10 feet above the ground. It required only a few minutes to chop a hole large enough to admit a man. T. E. Cockrell, with a .22-caliber repeating rifle, immediately crawled through the hole into the tree and stood up on a clump of cypress knees growing in the cavity. The day was bright and the hole being on the south side of the tree admitted considerable light. The hunter's head was just even with the lower edge of the opening as he balanced himself on the knees. Almost immediately one of the otters came crawling over a low clump of roots toward the light. Cockrell shot it through the head and repeated the action on two others that slowly followed the leader. The dying animals plunged once or twice and kicked spasmodically as life ebbed away. When all was quiet again, the fourth and last otter crawled into the light and was likewise shot. But this one was not hit as vitally as the others, and in threshing around it became wedged in a depression between two cypress knees. Cockrell was

forced to chop off several knees to reach the otters, and had considerable difficulty in removing the one that had fallen into the depression.

More than half of the space inside the cypress was taken up by knees. The floor was of black mud, with a shallow pool of water on the side next to the root entrance. Nothing that resembled a nest was found, although a comparatively dry space nearly under the chopped opening may have served for sleeping. This part of the floor was some two feet higher and 15 or 18 feet distant from the root entrance. The sight or odor of stored fish or other food was not recalled and Cockrell doubts that such material was present.

Although there was little water inside the tree, it is certain that during floods a depth of several feet often occurred. This was more than enough to eliminate the cavity as an otter den, although the animals could conceivably have lain atop a certain burled, flat-topped knee in the cavity.

The four otters proved to be two males and two females. One pair was larger than the other, suggesting that the animals may have been mates with pups of the year.

Early in January, 1912, the Cockrell brothers killed another group of otters. Two negroes had located them in a cypress log in Gayden Brake, Leflore County, and the brothers were attracted to the scene by the sound of chopping and excited whooping. The negroes were working near the top of the fallen tree, where the otters had entered. Approaching from the opposite end, the Cockrells saw four otters grouped in the flaring, hollow, butt of the log evidently in the act of escaping. This sudden appearance of man perhaps checked the animals' dash for freedom, and they apparently hesitated to retreat back toward the din and commotion at the top end of the log. T. E. Cockrell shot three of the confused otters; the fourth ran back into the cavity. Later, it was chopped out and shot. As in the former case, two of the otters were somewhat larger than the other two. The sex, not recalled with certainty, was thought to be three males and one female. The four probably constituted a family group.

There is some doubt that this log served as an otter den, although the four animals were evidently using it as a daytime retreat. Only the incoming tracks, not a well-defined trail, led to the hole in the top of the fallen tree.

A trapper by the name of Smith, also in January, 1912, and from Gayden Brake, secured two large otters from the base of a cypress tree. Both were shot with a .22 repeating rifle, one inside the tree and the other as it ran out of the cavity. The sex is not known. This tree was standing partly in water, well back in the swamp.

In early February, 1913, Hufstickler, a professional otter hunter operating on Mossy Lake, Leflore County, trailed an otter family to its den in a large, burned-out cypress log. The unusually large entrance to this den was three feet in diameter. Hufstickler plugged it previous to chopping into the log. During the chopping process, one otter was seen to slip out of an undiscovered hole near the top and escape. The hunter hastily closed this exit and suc-

ceeded in shooting a large otter hiding inside. He believed that more than one animal may have escaped unseen. The trail was so packed by tracks that the exact number of otters entering the log could not be determined. This den log was nearly parallel to the lake shore and lay partly in the water.

Den location was a favored method of taking otters in the Delta. Most hunters considered it faster, easier, and more certain than trapping. "Denning" was preferably a two-man job, and trappers without a partner usually enlisted the help of some nearby person, often another trapper. Payment was made in money, almost never in equal division of the valuable otter furs. It is said that two trappers working within a few miles of each other, and on comparable grounds, might agree on an equal division of otters in return for assistance in capturing those located by each party during the season.

There were, however, otter trappers who specialized in the use of traps. The most common set was on logs lying in water two or three feet deep or deeper. In such sets half of a brick, in the total absence of native rock, was often attached to the trap to aid in holding the captured animal under water. Old trappers have told me that in making this set it was more difficult to conceal the brick than the trap. In other sets, traps were placed at slides and dens, especially when they could be staked in water of drowning depth.

Because of high fur value, otters were taken at every opportunity. Many old-time hunters devoted full time to the species. But after the rise in value of raccoon and mink furs, about 1910, otter specialists tended to become general trappers. They depended then on the likelihood of running across otter trails while setting traplines for minks and raccoons.

There is little doubt that Delta trappers found otters more difficult to trap than minks and certainly they were more difficult to hold. A trapped otter will readily twist off a foot, especially a front foot. Its movements may be exceedingly quick, and toe holds, particularly in heavily covered traps, were frequent. Moreover, due to the swampy nature of the Delta habitat, and the general scarcity of steep banks and therefore slides, otters at times were necessarily trapped on logs over shallow water. This condition prevented drowning except in cases where the bottom mud was sufficiently deep and fluid to induce exhaustion and suffocation.

The use of otter dogs, indicated by Bennitt and Nagel (1937) to have been common in Missouri, was not particularly common in the Delta. They are said to have been used near Rosedale and certain other old Mississippi River settlements, but not much in the deeper wilderness. There, the favored device was the trap, and somewhat later den hunting in conjunction with general trapping.

FUR CATCH AND VALUE

There is no doubt that large catches of common furs were made by Delta trappers as late as 1910 or 1915, and even later in some localities. Beaver and

otter hunters until about 1885 (Yeager, 1938) were said to average 30 or 35 beavers and 15 or 18 otters yearly. It appears that the beaver population declined rapidly after this date; otters, probably due to their relative scarcity and isolation, held up better, being common in 1900 and taken in steadily decreasing numbers over much of the Delta as late as 1920.

It was natural that price, in the Delta as elsewhere, should influence profoundly the fur catch. Until about 1910, southern minks averaged little more than one dollar, and raccoons only half as much. Opossum and wildcat furs were trash; some trappers saved the black opossums, which averaged a few cents. As a result, these species, despite the large populations, were, before 1910, comparatively untouched in still virgin localities. Raccoons, near settlements, were hunted for sport and sometimes shot out of the cornfields; minks were trapped in proportion to their depredations; opossums, of some impor-

TABLE 1.—*Primary Sale Value of Otter Pelts to Experienced Trappers, 1910–13*

TRAPPER	WHEN TAKEN		NO. OF PELTS	SIZE	CONDITION OF FUR	ACTUAL RETURN PER PELT	REMARKS
	Month	Year					
Cockrell Bros.	Dec. (early)	1910	4	2 large 2 medium	nearly prime	$15.00	warm curing weather; hair slipped
Cockrell Bros. and Negros	Jan.	1912	4	2 large 2 medium	fully prime	22.50	excellent, fully prime fur
Smith	Jan.	1912	2	2 very large	fully prime	38.00 47.50	both very dark; unusually fine quality
Hufstickler	Feb. (early)	1913	1	medium	fully prime	23.00	fully prime fur, slightly curled
Average price received, 11 otters.....						$23.50	

tance as sport and food, especially to negroes, were otherwise seldom molested. They were killed if caught in the chicken coops. Otter and beaver on the other hand had always returned the Delta trapper several dollars a pelt, and their capture had attracted for many years a small number of men who came to be considered professional otter and beaver hunters. After 1910, with the advent of better common fur prices, more men took up trapping and the specialists became general trappers.

The following data refer to the individual otters whose capture has been described herein. They supply some examples of the value of the species to the experienced trappers taking them.

These data show considerable variation in return value, even to experienced trappers. To inexperienced and negro trappers there was probably as much variation and almost certainly a lower average return. The latter groups

usually sold to traveling or local buyers. Most experienced trappers shipped their furs to large fur houses, especially to those in St. Louis.

Concerning the catch and value of common furs for the period in question, T. E. Cockrell has provided me with estimates or actual figures from which I have calculated the average annual value of fur catches to experienced trappers.

The largest one-season catch of any Delta trapper, for which I have record was made by T. E. Cockrell in 1908-09 in the "flat-woods" of Sunflower County, Mississippi, near the present village of Colony Town. He used about 100 traps, chiefly no. 1½ and no. 2 Victor and Oneida Jump; and began trapping about December 1 and quit on February 28. The catch and its value were as follows:

SPECIES	NUMBER	VALUE
Raccoon	355	$170.40
Mink	131	157.20
Opossum	40 (black only)	8.00
Otter	2	20.00
Wildcat	7 (not skinned)	
Total		$355.60

These data supply the basis for deriving the average price of pelts in 1908-09, as given in table 2. In 1912-13, this catch would have returned $1,541.55, or more, since the 40 opossums represent only the black individuals taken. In 1912–13, the trapper would probably have taken 200 opossums, and averaged about 60 cents a pelt for all color phases.

Hartman (1922) expressed the belief that about 10 per cent of the Virginia opossums in central Texas were of the black phase. If the same proportion holds for Mississippi, Cockrell's catch in 1908–09 would have been 400 opossums. He did not keep a record of the total opossum catch, but estimates that he took at least 300; he doubts that the catch was 400. It may be that black opossums ran higher than 10 per cent in the Delta. My arbitrary figure of 200 in table 2 is, therefore, conservative.

In February, 1909, T. E. Cockrell, on untrapped territory but in the same "flatwoods" vicinity, caught 155 raccoons in two weeks. This high catch was probably due to the fact that the trapper was working the best of the "flatwoods" habitat, had little or no competition, was not disturbed by night hunters, and was favored by both physical and weather conditions. Also, it may have been that the animals, in a region where hibernation is uncommon, were, in February, having some difficulty in finding food and were freely taking bait. Cockrell estimated that experienced Delta trappers, about 1908 or 1910, caught 250 to 350 raccoons a season, depending on ground. I have arbitrarily used 275 in table 2.

A total of 131 minks is likewise the best catch Cockrell ever made of this species. However, he believes that many Delta trappers operating in better mink territory exceeded this number in their best winters.

Early trappers made no effort to take opossums or wildcats. Practically all log sets made for raccoons and minks, and bait sets on land or at the water's edge, were good for these two low-value species. Most trappers resented even incidental capture, since such catches always stood a good chance of spoiling the set for the more valuable mink and raccoon.

Trappers operating near a plantation or small town often sold skinned raccoons and opossums to negroes and tenants, to whom such game was prized as food. The price ranged from 10 to about 35 cents for a rough-drawn carcass.

Although the data given in table 2 are too limited and local to be conclusive, it appears that a distinct reduction in the average seasonal fur catch occurred

TABLE 2.—*Comparison of Average Fur Catch and Its Value to Experienced Delta Trappers Before and After Increase in Value of Common Furs, 1908–09 and 1912–13. Season: December 1—February 28*

SPECIES	AVE. NO. OF ANIMALS TRAPPED PER SEASON		AVERAGE PRICE AND INCOME			
			1908–09		1912–13	
	1908–1909	1912–1913	Per pelt	Season	Per pelt	Season
Raccoon	275	150	$ .48	$132.00	$2.35	$352.50
Mink	80	60	1.20	96.00	5.25	315.00
Opossum[1]	40	200	.20	8.00	.60	120.00
Otter	4	2	10.00	40.00	20.00	40.00
Wildcat[2]	5	5	—	—	.15	.75
Total				$276.00		$828.25

[1] Only black opossums pelted before advance in prices about 1910.

[2] Wildcats were usually not skinned.

between 1908 and 1912. The prices of common furs went up sharply during this interval. T. E. Cockrell and others with whom I have talked believe that 1910 marks the beginning of the decline in common fur animal populations in the original, uncleared, and unsettled Delta. A decline attributable to extensive clearing and settlement occurred in many regions, of course, before this date.

Following the period of extensive land clearing which became Delta-wide about 1915, minks stood up better under severe trapping and habitat depletion than raccoons. This was because minks, being more closely associated with water, were left a livable habitat for a longer period. Aquatic areas, although heavily lumbered and subjected to the effects of erosion and pollution, were not altered to the extent of removing every tree, which did occur on the ridges and flats. Persistent trapping, drainage, and fire later extirpated

minks from many of the swamps, lakes, and streams. Opossums are now found in some of these aquatic areas, and this species is undoubtedly the most common and widely distributed fur animal now present in the Delta region.

It has been difficult to obtain satisfactory data of a quantitative nature on the early Delta fur yield. T. E. Cockrell has provided the best information I have on this subject. In 1908–09, the year of his best catch, Cockrell's trapping operations covered about 45 square miles. Trapping here was by no means exhaustive; seldom were traps left at one location more than a few nights. It is believed that less than the annual increase was removed. The per cent of the total population removed cannot be estimated. In yield, it amounted to 7.88 raccoons and 2.91 minks a square mile.

TRAPPERS AND TRAPPING METHODS

It is evident that several types of trappers have operated in the Delta, evolving from the beaver hunter of the era of exploration to the local tenant and negro trapper of the present time (Fig. 2). The earliest beaver hunters, who date back to the period of exploration, probably did not deliberately pursue the otter, but at an early date came to value this fine fur. Transition to the beaver-otter specialist is not well defined and I have no specific information concerning it. My grandfather has indicated to me that before 1870 the rifle was the chief reliance in taking these furs. Traps steadily replaced the rifle after this date. It seems certain that the beaver-otter trapper was active up to about 1885, after which beaver are said to have declined sharply in numbers. With the decline in beaver, these hunters pushed on, some probably into Louisiana and Arkansas, some quit, others concentrated more than ever on otters, and the remainder became general trappers. Many of them hunted egrets and herons for their plumes during the spring and early summer.

The period between 1890 and 1905 or 1910 can perhaps be called the "otter era" in the Delta, since it followed the passing of beaver hunting and preceded the rise in value of common furs. My information on this class of otter hunters indicates that they were bearded, solitary woodsmen, usually bachelors, who returned to the same camp and grounds year after year. They traveled by "dugout," as the earlier beaver-otter hunter did, going into the wilderness in the fall and returning late in the winter or in the spring. These woodsmen commonly made their cypress "dugout" boats unaided, usually during the summer, and often owned two sizes, a large boat for freighting and a smaller one for light, fast travel. The paddle or push-pole rather than oars was invariably used. They lived usually in log cabins covered with cypress puncheons on some high-banked lake or bayou in the vicinity of good otter country. Partnerships apparently were not common.

After 1905 or 1910, the otter specialist gave way to the common fur trapper. The period from about 1905 to about 1920 undoubtedly marks the Delta hey-day of the common fur hunters. The number of trappers grew apace.

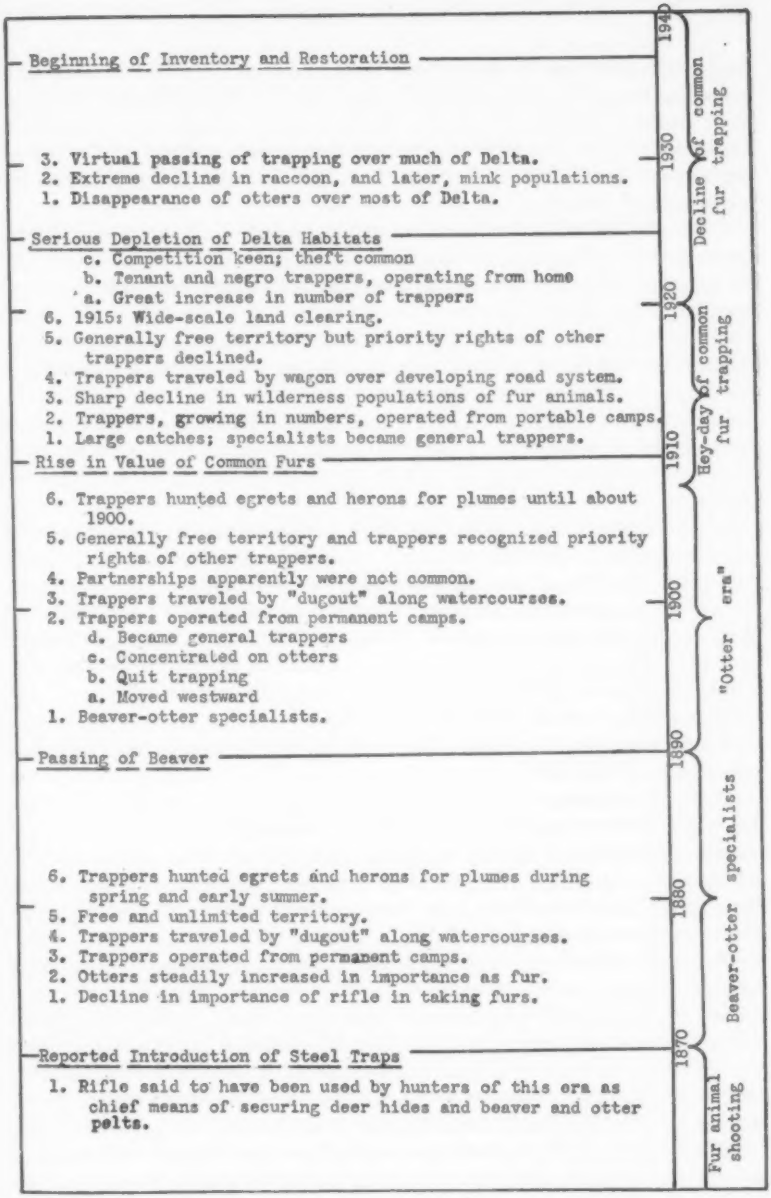
1940
1930
1920
1910
1900
1890
1880
1870
Beginning of Inventory and Restoration
3. Virtual passing of trapping over much of Delta.
2. Extreme decline in raccoon, and later, mink populations.
1. Disappearance of otters over most of Delta.
Serious Depletion of Delta Habitats
c. Competition keen; theft common
b. Tenant and negro trappers, operating from home
a. Great increase in number of trappers
6. 1915: Wide-scale land clearing.
5. Generally free territory but priority rights of other trappers declined.
4. Trappers traveled by wagon over developing road system.
3. Sharp decline in wilderness populations of fur animals.
2. Trappers, growing in numbers, operated from portable camps.
1. Large catches; specialists became general trappers.
Rise in Value of Common Furs
6. Trappers hunted egrets and herons for plumes until about 1900.
5. Generally free territory and trappers recognized priority rights of other trappers.
4. Partnerships apparently were not common.
3. Trappers traveled by "dugout" along watercourses.
2. Trappers operated from permanent camps.
d. Became general trappers
c. Concentrated on otters
b. Quit trapping
a. Moved westward
1. Beaver-otter specialists.
Passing of Beaver
6. Trappers hunted egrets and herons for plumes during spring and early summer.
5. Free and unlimited territory.
4. Trappers traveled by "dugout" along watercourses.
3. Trappers operated from permanent camps.
2. Otters steadily increased in importance as fur.
1. Decline in importance of rifle in taking furs.
Reported Introduction of Steel Traps
1. Rifle said to have been used by hunters of this era as chief means of securing deer hides and beaver and otter pelts.
Decline of common fur trapping
Hey-day of common fur trapping
"Otter era"
Beaver-otter specialists
Fur animal shooting

FIG. 2. Chronology of trapping in the Delta Region.

Log camps gave way to the portable tent. After about 1915, the number of tenant and negro trappers greatly outnumbered all others; they operated from their homes, working the neighborhood swamps, creeks, and woodlands. Competition grew, and theft of traps and furs became common. Fur animal populations dropped precipitously, due to the dual toll of trapping and the conversion of the wilderness into cotton land.

T. E. and W. S. Cockrell were probably typical of the more experienced trappers during the height of this fur-hunting era. Between 1900 and 1916 they worked either separately or as partners. After 1907 both took to general trapping. In order to live as nearly on their grounds as possible, they came to prefer the ordinary canvas wall tent, about 12x14 feet, equipped with a fly. A rough board floor was always used, and the camp was heated and meals prepared on an ordinary wood-burning stove.

In moving camp, mules and wagon served as transportation. To reach a favored spot on or near their actual trapping grounds, the trappers often went ahead to clear a way through the woods and the driver with his team, hired for the occasion, followed as rapidly as the trail allowed.

In establishing camp, the first job was to drive a sand-point pump in order to insure water for drinking and other camp use. The teamster was always retained until after a successful pump had been sunk, with which he assisted. Depending on the depth necessary to go, a sand-point could be mauled into the ground in two or three hours. These small lift pumps were not effective at depths over 32 feet, and if water was not obtained before reaching this depth, the pipe and point had to be pulled and the camp site relocated. Second attempts to obtain water were not often necessary. If a trapper located on a clear lake or creek, he sometimes used this as a water supply. Springs were almost nonexistent.

Camp moving and reestablishment in most cases could be completed in a day's time. Since trappers of the 1910 era commonly moved to untrapped territory several times during the season, this allowed them to resume trap setting after the loss of only one day. Territory was plentiful until about 1910, later in some localities, and the owner's permission to trap desirable ground was seldom required. T. E. Cockrell established five camps during the season of 1908–09, and covered an area about three miles square from each location.

The trapline usually began at or very near camp. In the "flatwoods" where raccoons were the main catch, the line followed roughly the water's edge, whether swamp, creek, or lake. Swamps most commonly afforded trapping water. Some raccoon trappers set lines across the woods, using mainly the log set. In localities where swamps predominated, and the catch ran perhaps 50 per cent minks, the trapper worked out into the cypress and tupelo gum timber at various points, covered all inlets, outlets, and streams, and set many traps along the larger lakes. Only traps placed in the swamps proper

could be considered specifically as mink sets; all others were good for raccoons as well. Raccoons were, of course, taken in swamps, particularly in log sets. Hip boots were an absolute requirement in the way of equipment.

Even though log sets were efficient, most trappers preferred to place their traps in water. Log sets took everything from blackbirds to wildcats, and made many waste catches. Water sets were more quickly made, since a couple of thin, wet leaves served for covering, whereas, on logs, careful covering was necessary. Moreover, a smaller percentage of water-set sites was destroyed by captured animals, both because they were harder to destroy and because a considerable part of the catch, especially minks, drowned before extensive disturbance could be made. Raccoons, taken on logs, always tore off the decayed bark and sapwood leaving a conspicuous white area often several feet long. For this reason, experienced trappers seldom made sets directly in raccoon trails, which often paralleled the water's edge and were perhaps the most common fur sign in the woods. Instead, they chose a place in a few inches of water, several feet off the trail. If water of the proper depth was not at hand, this off-trail set was made on land. In both cases, the method was a variation of the well known stake-bait set, and bait was always used. This was rabbit or bird stapled to a tree or cypress knee 12 or 15 inches above the trap. A few handfuls of water, unless it was raining, were dashed over the bait and surroundings in an effort to remove human odor. Many trappers considered the baited water set the most satisfactory that could be employed.

Trappers gave considerable importance to fresh bait and habitually carried a small rifle or shotgun with which to replenish the supply. Rabbits, squirrels, and birds of all kinds except hawks and owls were considered good. Of birds, some trappers preferred red-headed woodpeckers (*Melanerpes erytrocephalus*), which were abundant. Birds and nonfur mammals taken in traps were used for bait. Domestic fowl and meats were almost never used and fish but seldom. W. S. Cockrell liked snakes for minks and secured them in the dormant condition by turning over logs. They were chopped into pieces several inches long before using. Commercial scent baits were employed to some extent after their introduction. Skinned carcasses were considered poor bait and many trappers did not like to leave them in the woods, thinking that they ran the game out of the country. It was common for trappers to pack a hundred pounds or more of trapped fur animals daily into their camps, weight equivalent to that of five or six raccoons. When the load became too heavy, a few of the raccoons would be skinned out.

A wide variety of nonfur species was taken in traps. Log sets took cottontail and swamp rabbits, the latter called "cane-cutters"; fox and gray squirrels; and occasionally chipmunks, flying squirrels, and woodrats (*Neotoma*). Of birds, the bronze grackle was perhaps most often taken in both log and water sets. So were herons of several species; ducks were occasionally caught.

I know one trapper who, in 1918, caught two wild turkeys in log sets the same day. Hawks and owls of several species were trapped at bait sets, both land and water. The writer has on numerous occasions taken screech owls, barred owls, red-tailed hawks, and red-shouldered hawks in traps placed in two or three inches of water at bait sets. T. E. Cockrell once caught a two-pound largemouth black bass in a trap, and W. S. Cockrell reported taking several catfish and small buffalofish. Turtles were sometimes taken on logs if trapping began early in November.

The food of Delta trappers consisted chiefly of staples: flour, cornmeal, sugar, coffee, potatoes, home-cured pork, and some butter and eggs. Game was varied and, of course, common, consisting of squirrels, rabbits, ducks, fish, and occasionally deer and turkey. Fried dishes were the rule. Trappers operating on lakes and the larger streams often kept a supply of fresh fish, chiefly channel cat, in willow-pole live boxes. These were secured on trotlines or on lines tied to branches of trees and bushes growing over the water.

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OBSERVATIONS ON THE LIFE HISTORY OF BAIOMYS TAYLORI SUBATER

BY W. FRANK BLAIR

Thirty-two live specimens of *Baiomys taylori subater* were trapped near La Belle, Jefferson County, Texas, on January 25 and 26, 1940. These were shipped alive to the Laboratory of Vertebrate Genetics at Ann Arbor, Michigan, but 23 of them died in transit or within a few days after their arrival at Ann Arbor. The weather was cold when the mice were shipped, and chilling probably was the cause of death. The surviving animals thrived in captivity,

however, and have produced about 100 offspring. They have been fed the standard *Peromyscus* ration (Dice, 1934). I am greatly indebted to Dan W. Lay of the Texas Game, Fish, and Oyster Commission for showing me the place in which the *Baiomys* were trapped, and for aid in obtaining permission to trap there.

HABITAT

The *Baiomys* were trapped in a small area of dense, tall grass (*Andropogon* sp.) surrounding a pond on a low, moist, coastal prairie. The area was fenced against grazing by cattle, which undoubtedly accounted for the excellent stand of tall grass. The tiny runways of the *Baiomys* were easily located beneath the thick mat of prostrate dead grass. The ground was partly covered with snow when the trapping was done, but the mice were active in spite of this unusual phenomenon in their environment. In the same place, two golden harvest mice (*Reithrodontomys fulvescens aurantius*), one eastern harvest mouse (*Reithrodontomys humulis merriami*), two Texas rice rats (*Oryzomys palustris texensis*), and one Texas cotton rat (*Sigmodon hispidus texianus*) also were taken. On the basis of the available evidence, none of these other species was nearly so abundant as was *Baiomys*.

REPRODUCTION

In the laboratory, *Baiomys* is a constant, although not prolific, breeder. In 202 days, one pair produced 9 litters or an average of one litter every 25 days. Another pair produced 8 litters in 221 days, or an average of one litter every 31 days. The average date between litters for 26 cases involving 6 pairs of parents was 27.6 ± 1.8 days (standard errors, instead of probable errors, are used). The longest period between litters was 64 days; the shortest was 20 days. Since one female had two litters only 20 days apart it appears that the gestation period is not more and possibly less than 20 days. Svihla (1932) found that lactation lengthened the gestation period in *Peromyscus*. Similar observations have been made on *Mus musculus* by Daniel (1910) and Kirkham (1916), and on the Norway rat by King (1913). Therefore, it seems quite likely that non-lactating female *Baiomys* would have a gestation period of less than 20 days.

The number of young per litter in 39 litters varied from 1 to 5, and averaged 2.72 ± .13 individuals. The average per litter, therefore, does not differ significantly from the averages that Svihla (1932) found in some laboratory stocks of *Peromyscus*.

The date of first breeding of 8 pairs of young *Baiomys* is known. In these pairs each mated male and female was of the same age, and each pair was placed together at the age of one month or less. The earliest age at which one of these females gave birth to a litter was 64 days, and the latest age at which a first litter was born was 101 days. The average was 81.5 days. In

two cases in which young males were mated with considerably older females first litters were born when the males were 66 and 68 days old, respectively. The age of first breeding is about the same as that found in field studies of *Peromyscus maniculatus bairdii* (Blair, 1940) and in laboratory stocks of *Peromyscus maniculatus* (Clark, 1938).

WEIGHTS AND DEVELOPMENT OF YOUNG

Three field-caught males, after being in captivity for 38 weeks, weighed 7.9, 7.3, and 7.2 grams, respectively. Three field-caught females, after 38 weeks of captivity, weighed, respectively, 9.4, 7.9, and 7.4 grams. The unmated captive *Baiomys* did not become excessively obese, as mice of the genus *Peromyscus* usually do in captivity.

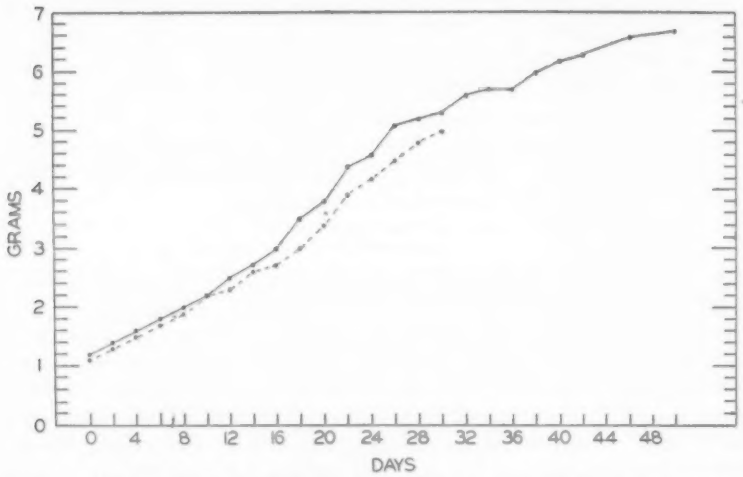

FIG. 1. Graph showing average increase in weight of young *Baiomys taylori subater*. Solid line represents average weights of three female litter mates. Dotted line shows average weights of 15 males and females.

Twenty-one young *Baiomys*, weighed within 12 hours after birth, averaged 1.1 grams each. Fifteen of the young were weighed every second day until they were one month of age, and one litter of three was weighed until it was 7 weeks old (Fig. 1). The weight of the young mice increased rather uniformly for about one month, and after that the rate of increase was less. At the age of 50 days, the young mice in a litter of three were approaching the weight of the field caught adults, and the largest of the young mice weighed the same as the smallest of the field caught animals.

Young *Baiomys* are pink at birth, but become darkly pigmented within 24 hours. Shortly after birth they become attached to the mammae of the mother and are dragged about wherever she goes. If the young are forcibly detached the male or female picks them up in its mouth and carries them into the nest. They soon become reattached to the mammae. The young, as far as I can ascertain, remain constantly attached to the mother until they are from 18 to 22 days old. The young of three litters became detached from the mother at the age of 18 days, whereas the young of another litter became detached when 22 days old. Apparently they are weaned at about the time they become detached, for after this time I never have seen one of the young sucking. Apparently young *Baiomys* are weaned at an earlier age than are young *Peromyscus*, for Svihla (1932) found 22 days to be the minimum age of weaning in *Peromyscus maniculatus* and *P. leucopus*. However, no data are available for *P. polionotus*, which is the smallest of the genus.

The eyes of the young opened at the age of 12 days in two litters, at 14 days in one litter, and at 15 days in another litter. The eyes open at about the same age as in *Peromyscus maniculatus* (Svihla, 1932).

The juvenile pelage is predominantly dark gray, but numerous brown hairs also are present. The contrast between juvenile and adult pelage consequently is much less than in all subgenera of *Peromyscus* except *Ochrotomys*. Three young *Baiomys* that were under periodic observation showed adult pelage beginning to replace the juvenile at an age of 46 days. The adult pelage first appeared on the sides of the body and on the head, then extended from the sides toward the mid-dorsal line and from the head backward.

SOCIAL RELATIONS

Captive *Baiomys* are much more tolerant of one another than are mice of the genus *Peromyscus*. There has been no evidence of fighting among the 2 to 4 individuals kept together in each cage, or when a second litter was born to a mated pair before the first litter had been removed from the cage. In a mated pair, the male parent seemed as solicitous of the young as did the female. In several instances when the young mice were removed from the nest the male carried them back, carefully washed them by licking, and then stood guard over them until the female came to care for them. In this habit of caring for the young male *Baiomys* are different from male *Peromyscus*.

VOICE

The most frequently heard call of captive *Baiomys* is a high-pitched, barely-audible squeal. Before uttering this call an individual usually climbs up the side of its cage or gets on top of its nest pan. During the calling the head is thrust forward and upward, stretching the throat. The posture of the animal resembles the "singing" posture of the coyote (*Canis latrans*). A somewhat similar call has been described for the grasshopper mouse (*Onychomys leuco-*

gaster) by Bailey (1931) and in the golden harvest mouse (*Reithrodontomys fulvescens*) by Svihla (1930). I have never observed this phenomenon in *Peromyscus*.

On one occasion, a female that had newly born young uttered a scolding sound, somewhat like that used by *Peromyscus*, whenever one of the three males in the same cage approached her and the young. Unlike most *Peromyscus*, *Baiomys* do not squeal when they are picked up and handled.

SWIMMING

The swimming ability of three field-caught *Baiomys* was tested in a large sink full of water. All were excellent and rapid swimmers. In swimming, they held their heads well out of the water and paddled rapidly. After about a minute in the water their fur became quite water-soaked as it does not repel water nearly so well as does the fur of the meadow vole (*Microtus pennsylvanicus*).

SUMMARY

In breeding rate and in the rate of development of the young, *Baiomys* do not differ from some species assigned to the genus *Peromyscus*. On the other hand, captive *Baiomys* are much less inclined to fight among themselves than are captive *Peromyscus*, and the males, unlike *Peromyscus* males, assist the females in caring for the young. Unmated captive *Baiomys* do not become excessively fat, in which they differ from the usual condition in unmated *Peromyscus*. *Baiomys* utters a characteristic call note. A similar note has been observed in the genera *Onychomys* and *Reithrodontomys* but never in *Peromyscus*. The difference between adult and juvenile pelage is much less than in all subgenera of *Peromyscus* except *Ochrotomys*.

In its native habitat, *Baiomys* makes and follows beaten paths similar to those characteristic of microtine rodents. In its preference for heavy grass cover and in making microtine-like runways *Baiomys* exhibits one of its greatest habitudinal differences from mice of the genus *Peromyscus*.

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MAMMALIAN INVASION VIA THE HIGHWAY

BY LAURENCE M. HUEY

Much has been written about the destruction of wild life along the modern well-traveled highways. The register of casualties of birds, reptiles, and mammals ever grows. Yet there is another aspect that has not been publicized, namely, the aid provided by highways in the dissemination of some forms of animal life other than human. Botanists have recognized the spread of several noxious weeds along highways, and now the mammalogist can come forward with an example of rodent movement for which the same route is responsible. The following is an account of the way pocket gophers (*Thomomys*) are extending their range across a bleak and barren expanse.

The area of observation is a fifty mile section of arid sandy desert that lies between the High-line Canal, ten miles east of Holtville in Imperial County, California, and the Colorado River near Yuma, Arizona. The greater part of this region is composed of sandy silt deposits, with a sparse growth of creosote bush and a few mesquites—plants that can sustain themselves under the most extreme drought conditions. Sporadic desert rainstorms bring forth annuals where conditions are favorable, but no regular season exists and several years may pass without the appearance of even the smallest annual growth.

Diagonally across the near center of this area, from northwest to southeast, lies a chain of wind-blown sand hills. This section is even more repellent to vegetative growth than the more stable sandy-silt plain and is decidedly unfavorable as a habitat for *Thomomys*. In fact, before main highway development started, no part of the entire fifty mile stretch was suitable for gophers. There was neither sufficient moisture in the soil nor enough root stock or annual growth for food to maintain gopher life. On the other hand, other forms of desert mammals suited to this environment were abundant. Large colonies of desert kangaroo rats (*Dipodomys deserti*), Merriam's kangaroo rats (*Dipodomys merriami*), two or more species of pocket mice (*Perognathus*), and a ground squirrel (*Citellus tereticaudus*) were present. From these animals the vehicles passing over the present highway exact enormous toll each year, to the point of almost eliminating the larger species along a wide area on

either side of the pavement. Yet close beside this lethal avenue the fossorial pocket gopher is successfully extending its range.

By way of a word of history, it might be stated that the writer first saw this region in March, 1916. At that time two deeply scored wheel tracks in the sandy silt led eastward from the same bridge-head that marks the crossing of the canal today. The perilous sandy trail led to an experimental plank road, consisting of two lines of parallel timbers, placed end to end and tied together with nailed two-by-fours, across the seven miles of rolling sandy hills. This improvement was short-lived and was replaced in 1920 by a road made of heavy dimension planks, laid corduroy, tied with steel straps. At the same time the road over the silty-sand plain was oiled and along this the first casualties amongst the kangaroo rats occurred.

Since 1923 the writer has crossed this desert several times each year but never saw any signs of the spread of gophers in the days of the old oiled road. It was apparently not until the present cement highway was built (a triumph of engineering across the sand hills) that the means for gopher range-extension was created. This project was completed in 1928.

In mid-January, 1941, the writer noted with interest the advance made by *Thomomys* in twelve years. On the western end of the highway fresh mounds were found by the roadside close to the sand hills, a distance of thirty-seven miles from the canal. On first thought it might be suggested that these gophers came from the more open plains of the surrounding terrain, but the writer through the years has watched the gradual progress of these animals eastward from the more suitable gopher regions near the canal. Previously, however, no evidence of gopher mounds had been seen as far east as the edge of the sand hills.

On the eastern end the movement has not been so rapid. While the gopher population of the delta land in the vicinity of the Colorado River through which the road passes is perhaps as dense as that in the Imperial Valley near the canal bridge, the soil that forms the road bed is not as suitable to gophers. It is dryer, better drained, more clayey and with less vegetation. Yet a vanguard has advanced, as a few scattered mounds were found at a point three miles west of the river's influence.

The seven miles of sand hills still offer an insurmountable barrier and as yet no evidence of gopher life has been observed along the highway in this section. How long their passage will be obstructed is questionable, and in any event it is unlikely that the highway will ever be the means by which they will cross this hurdle. However, the huge "All American Canal," when put into operation for supplying water for irrigating this great western section, will offer the gophers their chance for completing the invasion.

Searching for factors that made this expansion of range possible, a two-fold answer is apparent—an increased moisture content of the soil by the roadside and the gopher's subterranean habits. To even the casual observer the more

luxuriant plant growth by the side of a hard-surfaced road is evident. The reason is that the soil there, due to the impervious surface of the pavement, receives at least twice as much water from rainfall as the more open country.

In the desert, the ground at the very edge of the pavement, during even a slight rainstorm, reaches a point of near saturation in many places. Furthermore this area of heaviest moisture is greatly benefited by the presence of the pavement, which acts as a cap or seal against evaporation. Thus is created along the highway a "moist soil condition" of precisely the type suitable to *Thomomys* and they are quick to accept it. The moisture naturally makes for better and more abundant plant growth, providing ample food for the travelers.

The fossorial habits of the gophers also prove to their advantage, for, unlike the kangaroo rats, "above ground" excursions of these animals are few, and the resulting traffic casualties are proportionally reduced. All in all, it is evident that the paving of this desert highway has afforded to this species its means of expansion.

It may be asked why the oiled road did not have the same effect. The reasons are obvious. This type of pavement, a heavy black crude oil poured on the desert sand, is decidedly porous and does not conserve moisture. In addition, it is so softened by heat during the summer that the pounding wheels of traffic would collapse any burrows beneath it, preventing the passage of gophers.

As compared with no gopher activity beside the oiled road, the present population offers a marked contrast. On the mid-January, 1941, day previously mentioned, the season was most propitious. Some rain had fallen over the area during December and the gophers had all commenced their surface activities. Within a measured mile, far out along this desert highway, nineteen fresh mounds were counted. While not an accurate index of the gopher population, this figure offered some evidence of the numbers of gophers that are now supported along the fringe of the road.

The facts outlined in this paper are becoming well recognized by "up-to-date" collectors. They have found that the easiest way to obtain a good series of gopher specimens on the desert in the shortest length of time is to search for burrows beside the highway.

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HOME RANGE OF THE COTTONTAIL IN CENTRAL MISSOURI

By Charles W. Schwartz

The home range of a species is one of the most important elements in its management. No definite information has been available hitherto concerning the home range of cottontails in Missouri, and only recently has there been such information from other states.

In studying this problem from December 1938 through March 1940 several questions were considered: (1) Is the range the same every season, or does it vary in size during the year? (2) Do rabbits occupy ranges located in the same places, season after season and year after year? (3) What is the range of a young rabbit, and does it continue to occupy the home territory as an adult? (4) Is there any correlation between sex and extent or type of range?

In central Missouri the cottontail appears to be an intergrade between two subspecies, *Sylvilagus floridanus mearnsi* (Allen) and *S. f. alacer* (Bangs). The former is found in northern Missouri, the latter generally south of the Missouri River.

TRAPPING AREA AND METHODS

Trapping was done on the University of Missouri Arboretum and Wildlife Experimental Area near Ashland, Missouri, 16 miles southeast of Columbia, established in 1938 by the federal government as part of its program for retiring submarginal land from agriculture. The part of the Ashland Area used consists of 100 acres of Boone silt loam, roughly rectangular in shape, and occupying an open ridge with wooded, oak-hickory slopes. A seldom-used gravel road traverses the area from north to south. The upland-herbaceous cover is relatively uniform and for this reason no cover-map is shown. The principal plants are staghorn sumac (*Rhus glabra*), fleabane (*Erigeron canadense*), goldenrod (*Solidago canadensis*), white oak (*Quercus alba*), Kentucky blue grass (*Poa pratensis*), broom sedge (*Andropogon virginicus*), poverty grass (*Aristida oligantha*), tickle grass (*Agrostis scabra*), sassafras (*Sassafras variifolium*), black locust (*Robinia pseudo-acacia*), lespedeza (*Lespedeza stipulacea* and *L. sericea*), wild bean (*Strophostyles helvola*), dewberry (*Rubus flagellaris*), and persimmon (*Diospyros virginiana*).

The traps used were those described as "cat traps" by Silver and Jarvis (1930). No geometric system of trap locations was employed; they were scattered over the area so that every part of it was sampled monthly. The traps were moved on the first day of each month. Apples and carrots were used as bait and appeared to be equally effective. Trapping was carried on daily when possible, although sometimes it was necessary to close the traps for a few days, especially during the severe weather of January and February 1940, when at times the road into the area was impassable. There are 8,819 trap-days involved in this study. Trapping in the timber was unsuccessful.

The captured rabbits were marked in one of two ways: At first the ears were tattooed; later small metal ear-tags, such as are used in marking fish, were employed exclusively. Both devices were satisfactory, but the tags, which could be fastened to the ears by means of crimping pliers, were more quickly and easily used. The following data pertaining to the present paper were recorded from each rabbit captured: Trap number, date, location, sex, weight, weather, and bait used. The animal was released at the point of capture.

OBSERVATIONS AND DISCUSSIONS

Age determination.—It is not difficult, of course, to distinguish young rabbits from adults early in the year, but as the young become larger a basis for distinction is difficult to find. At this intermediate level no specific basis was found in gross study of the reproductive organs, color of the pelage, condition of the teeth, size, or total length. The weight remained as a possibility.

TABLE 1.—*Number of individuals and times trapped*

NUMBER OF TIMES TRAPPED	MALES	FEMALES	TOTAL
1	61	66	127
2	24	28	52
3	17	14	31
4	3	7	10
5	5	6	11
6	4	4	8
7	2	3	5
8	1	1	2
9	0	1	1
10	0	1	1
11	1	1	2
15	0	1	1
19	0	1	1
22	2	0	2
Totals	120	134	254
Rabbits trapped more than once	59	68	127
Total number of captures	298	339	637

When the weights of all the rabbits taken (including those shot for study of the reproductive organs as well as those trapped in this study) were compared, two series were found. From March to September there was a heavier series, all of the females weighing more than two pounds two ounces (963 grams) and all of the males weighing more than two pounds (907 grams). These were considered adults because there was a distinct gap between the lightest animals of this series and the heaviest animals of the second and noticeably lighter series. The latter, which were considered young rabbits, approached the adults in weight; the two series merged from September on. When the

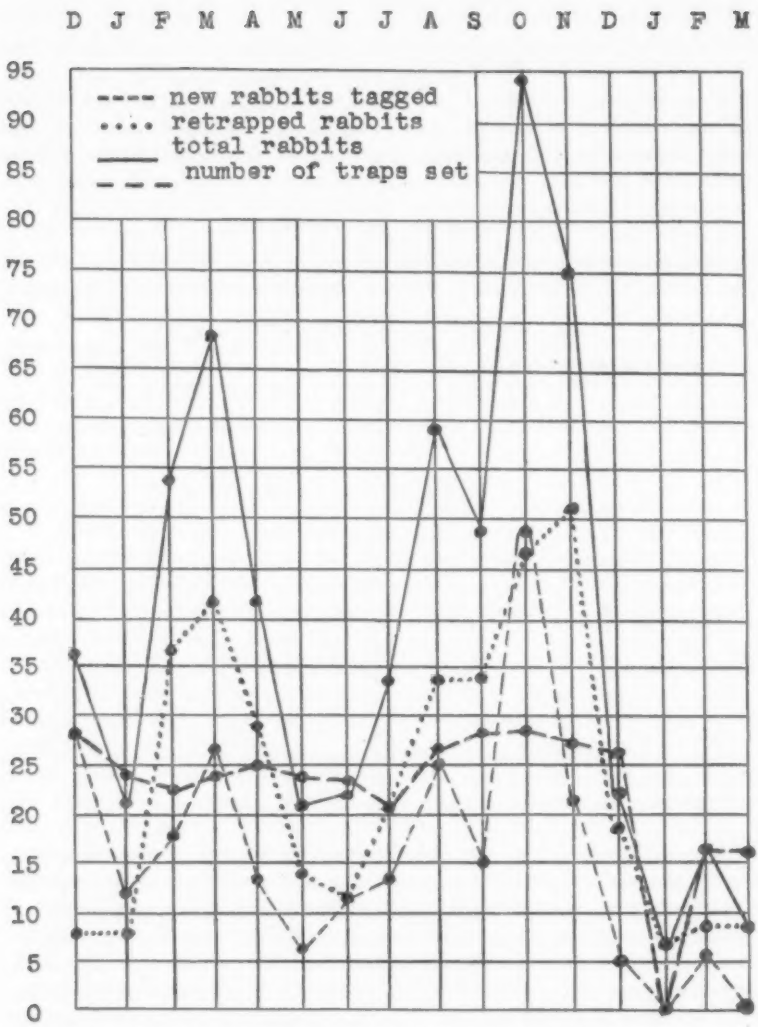

FIG. 1. Number of traps set and number of rabbits caught per month, from December 1938 through March 1940.

young rabbits became as heavy as the minimum in the adult group, they were treated thenceforth as adults. Whether at this time they became sexually

mature is a question that cannot be answered from the data collected because (1) the average weights of known adults become slightly lower as fall approaches, and (2) the size of adult gonads also decreases in the fall, reaching the size to which they have increased in young animals.

Individuals and captures.—In all, 254 different cottontails were marked. Of these, 127 were retrapped more than once, as shown in Table 1.

The number of rabbits caught per month and the number of traps set is shown in Figure 1. (The seven rabbits "retrapped" in January were actually tagged rabbits that were shot, the records being the same as though they had been retrapped.) There is no constant relationship between these numbers. Figure 1 shows further that there were two "peaks" during the year when more rabbits were caught than at other times: in February, March, and April, and from August through November. The first "peak" may be related to the onset of breeding activity. The second seems clearly associated with the actual peak of population, which occurs between August and November when naturally more animals can be caught.

Sex ratio.—The sex ratio of 156 adult rabbits trapped once was 44 per cent males to 56 per cent females; of 98 young rabbits trapped once, 53 per cent were males, 47 per cent were females; of 254 adults and young trapped once, 47 per cent were males, 53 per cent were females. Dalke and Sime (1938) found a "decided sex difference in rabbits re-entering the traps. . . . . the males displaying a consistent tendency to stay out." They found that 59 per cent of the 49 rabbits trapped three or more times were females, only 41 per cent were males. The comparable Missouri figures are as follows: Of 75 rabbits caught three or more times, 45 per cent of the 47 adults were males, 55 per cent were females; the 28 young rabbits were evenly divided. Considering both adults and young, 47 per cent were males, 53 per cent were females.

Recorded home range.—A map was made for each rabbit trapped, showing the date and location of the trap each time the animal was caught, and the distance between successive captures. There were 382 recaptures, all but ten of which were retrapped between 97 and 991 feet from the place where originally trapped. There was then a gap of 331 feet and the ten exceptional measurements lay between 1,322 and 3,542 feet; they will be discussed below. When the maps were studied, they were found to fall into two general groups: (1) those whose points lay along a straight (or almost straight) line, so that no two-dimensional figure could be drawn; and (2) those whose points permitted the drawing of a polygon representing the recorded (although not necessarily the entire) range of the animal. In the second group the outside points on each map were connected and the resulting area was measured with a planimeter. The rabbit had probably travelled over territory not included in such a figure, but there was no way of proving this to be the case. Therefore the recorded range is used as the closest approximation to the true range of each animal.

Average adult ranges.—The average adult ranges, taken from the polygons of 18 males and 20 females, drawn as just described, are shown in Table 2. These represent areas on which the animals were found during the entire trapping period. When the coefficient of correlation was calculated, no significant relationship was found between the number of times an animal was trapped and the size of its recorded home range.

The size and shape of the polygon is probably related to the amount and distribution of available food and cover, and it may vary with these conditions (Allen, 1939). On the portion of the Ashland Area used for trapping, the food and cover are quite uniformly distributed, and this fact may explain the small average size of the ranges as well as the small variation in size, considered in relation to the area that might easily have been traversed by the animal. Ten males and eight females were retaken during the second year of study on the same home ranges as during the first year, while only one male and one female were retaken elsewhere; these were found in the adjacent woodland during heavy snow (*cf.* below).

All of the cottontails retrapped (except the ten mentioned above that travelled unusual distances) were caught on the same areas at different times

TABLE 2.—*Recorded home ranges of males and females*

NUMBER OF ADULTS FOR WHICH POLYGONS DRAWN	MINIMUM (ACRES)	MAXIMUM (ACRES)	AVERAGE (ACRES)
18 males	0.17	4.0	1.4
20 females	0.15	4.9	1.2

throughout the entire trapping period. There is not enough evidence to show that the summer range of an individual is smaller than its winter range, although this seems likely. As for a migration between ranges at different seasons, only ten of the 127 animals trapped more than once travelled far enough to leave the home range (less than 5 acres in size) they occupied. There was no correlation between their unusually extensive movements (from 1,322 to 3,542 feet) and any seasonal changes. Forty-six young cottontails remained in their original nest-territory as adults, while only five moved to new territories.

The ten distances between 1,322 and 3,542 feet were traversed by five young and five adult rabbits. The cause of these emigrations is not known, but as already pointed out they are regarded as exceptional. They may have been due to population pressure in consequence of which young rabbits, and even some adults, find it necessary to move to new territories, or there may have been pursuit by predators. There is no evidence that these longer journeys are associated with more extensive movements prior to the breeding season. Dalke and Sime (1938) also report a few cases of extended emigration. They found that one adult male moved one mile, while two young females and one

young male shifted their ranges 1.1, 1.4, and 2.4 miles respectively. Hickie (1940) cites cases of three cottontails moving one-half, three-fourths and sixteen miles respectively.

During the first winter of this study, the cottontails were found in the open fields and edgegrowth, but during the severe snow in the winter of 1939–1940 there is evidence that they moved to an "emergency range" in the adjacent woodland. The distances from home range to emergency range in all cases were not greater than those travelled at other times. Tracks, pellets, and cuttings were found in the nearby timbered ravines, and rabbits were seen feeding there. During the same period on the trapping-area, none was caught and very few tracks were seen in the snow. To determine whether the animals went into the woodlands nearest to their home ranges on the trapping-area, shooting was resorted to and each rabbit's location when shot was recorded on its map. Ten of the twelve marked rabbits shot in the woods were at points immediately adjacent to their home ranges. The other two were animals whose home ranges had been near the center of the trapping-area.

Seton (1929) stated that the cottontail probably spent its entire life within a single acre unless chased away. Dalke and Sime (1938) found that the home ranges of 17 adult females (*S. f. mallurus*) averaged about three acres in size (minimum 0.6; maximum 8.4), while those of 10 adult males averaged 8.3 acres in size (minimum 0.52; maximum 12); the larger ranges that they found may perhaps be explained by conditions of food and cover different from those present on the Ashland Area. Dalke (1937) found that the fall range of *S. f. mallurus* was from 0.5 acre to 1.8 acres, but that both sexes travelled about a third of a mile to the ranges that they occupied in January and February.

Allen (1939) stated that the home ranges of 19 females averaged 2.22 acres, those of 17 males 3.62 acres, during January, February, and March, although he believed that their actual winter range was between five and ten acres. His data were obtained only in the winter months, but since he found that certain rabbits occupied the same territories for two or even three years, it may be that these seasonal ranges represent the true home ranges of his animals (*S. f. mearnsi*). On the other hand, it is still possible that the range at other seasons is quite different in size.

Hendrickson (1936) studied the summer range of *S. f. mearnsi* by means of sight-identification and pellet counts. The range of four rabbits averaged 0.58 acre, of another four 0.11 acre; that of another one was 0.23 acre. This seems to suggest also that the summer range of a single individual may be smaller than its winter range, which in turn may be associated with the reduced amount and availability of food and cover during the winter season.

This paper is condensed from part of a thesis submitted in partial fulfilment of the requirements for the degree of Master of Arts at the University of Missouri. The study was carried on under the direction of Dr. Rudolf Bennitt, Professor of Zoology, and I wish to express my appreciation to him.

Thanks are also due the following: to my wife, Dr. Elizabeth Reeder-Schwartz, to Dr. Paul D. Dalke, Associate Biologist, U. S. Fish and Wildlife Service, and to Mr. I. C. Adams, Jr., graduate student at the University of Missouri. The Missouri Cooperative Wildlife Research Unit provided equipment, ammunition, transportation and other facilities.

SUMMARY

1. In this study there was no constant relationship between the number of traps set and the number of rabbits caught per month.

2. There was no significant tendency of either sex to re-enter the traps repeatedly.

3. The average recorded home range of the adult male cottontails trapped was 1.4 acres, that of the adult females 1.2 acres.

4. No significant relationship was found between the number of times an animal was trapped and the size of its recorded home range.

5. No extensive shifts of population occurred during the 16-months' trapping period, although a few adult and young rabbits moved to new locations.

6. During the severe weather of January and February 1940, cottontails left the open area and entered the adjacent woodlands.

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SNOW BURROWS OF THE RED SQUIRREL (TAMIASCIURUS)

By George A. Petrides

An excellent opportunity for the study of several tunnel systems of the red squirrel (*Tamiasciurus hudsonius loquax*) was afforded the author while studying hedgerow ecology on farmlands in the vicinity of Cornell University at Ithaca, New York, during the winter of 1939–40.

According to the literature, red squirrels excavate snow burrows (1) in order to reach underground storehouses (Klugh, 1928); (2) to reach food upon the surface of the ground (Seton, 1909; Klugh, 1928); (3) to form passageways from tree to tree (Hatt, 1929); or possibly, (4) to have a snug place to use as a "playhouse" (Seton, 1909). Of the snow tunnel systems seen at Ithaca, however, probably the most interesting was constructed to aid in the removal of fruits from several large nannyberry (*Viburnum Lentago*) plants that were located in a hedgerow 50-125 feet from a woodlot. This situation was first noticed on January 9, 1940, at which time tracks, droppings, snow burrows and kitchen middens indicated that both grey and red squirrels were collecting many entire fruits from the plants but eating only the large, flat seeds. The fruits had been removed, bitten in half, the seeds extracted, and the fleshy portions dropped to the surface of the snow.

Beneath the shrubs, a complicated network of burrows through the snow came often to the surface and about the mouths of entrances, particularly those laterally placed, small piles of fleshy fruit remains were present. Evidently many fruits had been carried to burrows and the seeds eaten there. As indicated by tracks and grey putty-like droppings, all fleshy fruit remains were taken by cottontail rabbits. The entire supply of hundreds of fruits was found to be completely consumed by both squirrels and cottontails, on January 18, 1940.

Connecting the residential woodlot with the food plant burrow network, the main part of which was more than 100 feet away, a single tunnel extended through the hedgerow snow drift that extended at right angles to the woodlot. This connecting burrow often came to the surface as if the excavator had found it occasionally necessary to get his bearings. From these exits tracks invariably led into entrances less than a foot away. As this tunnel neared the network, a series of bifurcations led to its various parts.

Both horizontally and vertically, the snow burrows measured two to two and one-half inches in diameter and double grooves of footprints were worn into the floors of the tunnels. The tunnels themselves were constructed just under the crust of the snow at a depth of approximately one and one-half inches (to the top of the burrow). No snow was brought to the surface by the squirrels. In all probability, as suggested by Klugh (*op. cit.*), the snow is merely packed against the tunnel walls as the animal advances.

On January 11, 1940, a similar tunnel system was found beneath several hawthorn (*Crataegus*) plants located in a hedgerow near another woodlot on

the hedgerow study area. A similar record of tracks, droppings, snow burrows, and middens indicated that hawthorn fruits had been removed from the plants, the seeds extracted and eaten in snow burrows, and the fleshy refuse portions consumed by cottontails.

On another area included in the hedgerow investigation, a colony of red squirrels was observed to spend the winter in several underground burrows located under a group of hickory trees (*Carya ovata*) in a hedgerow situated more than a quarter of a mile from the nearest woodlot. Several of the many entrances to these subterranean burrows were kept open throughout the period from late December to early April although covered at times by as much as four feet of snow.

Despite the occurrence of many tracks on the surface of the snow and, in all probability, the presence of underground food stores, a complicated burrow system was constructed throughout the hedgerow snow drift to a point approximately 150 feet to the east of the underground burrows. The entire area in which hickory trees were located was riddled by the tunnels of this rodent. From the few refuse heaps exposed at the mouths of snow burrows, and excavations made by the author, it was evident that this network permitted the reaching of hickory nuts lying upon the surface of the ground. Two similar instances in other localities in which hickory nuts had been retrieved by red squirrels from beneath the snow cover were also located. These latter were of a more temporary nature, however.

From the above, it is concluded that the red squirrel snow burrow systems observed were constructed (1) for protection and comfort while travelling and while eating food collected above the ground, and (2) to enable the collection of food materials covered by deep snow. No evidence was found to indicate that grey squirrels construct or utilize snow burrows.

SUMMARY

Several snow tunnel systems of the red squirrel were observed on farmlands near Ithaca, New York, during the winter of 1939–40.

One system was evidently constructed for protection and comfort while travelling to a feeding area and while eating nannyberry (*Viburnum Lentago*) fruits collected above the ground. Tunnel networks, in other instances, were built to permit the reaching of hawthorn (*Crataegus*) fruits above ground and hickory (*Carya ovata*) fruits buried under snow. No evidence was found to indicate that grey squirrels construct or utilize snow burrows.

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TOE-SUCKING IN BABOONS: A CONSIDERATION OF SOME OF THE FACTORS RESPONSIBLE FOR THIS HABIT

By Joseph Gillman

Thumb-sucking in the human infant occurs at some time or other in the life of nearly every child. Langford (1939) has attempted to assess the validity of the theories propounded to explain this phenomenon. Levy (1928, 1934, 1935) by adopting physiological procedures, has induced reactions equivalent to thumb-sucking in dogs, calves, and chickens. Apart from these limited experiments on lower animals there does not appear to be any record in the available literature that thumb-sucking ever occurs in primates including monkeys and apes.[1]

Although the writer has witnessed foot-sucking on numerous occasions in two young honey bears the present paper is devoted mainly to a record of thumb- and toe-sucking in the baboon. Mention will be made of the stimuli which normally provoke this reaction in the baboon. Thumb-sucking in the human infant will be examined in the light of the comparative information presented below.

MATERIAL

In 1939 as a result of the generosity of the University of the Witwatersrand and the Royal Society of London a baboon colony was established in the Anatomy department. Some 45 baboons (*Papio porcarius*) of different ages are now members of the colony; during the last year there have been numerous births. At the Johannesburg Zoological Gardens there is housed an excellent family group (*Papio hamadryas*) and births in captivity are a regular feature of the Zoo group.

OBSERVATIONS

Thumb- and/or toe-sucking was observed in two infants, out of a total of 6 that have been under observation since birth. One of these animals was bred in the colony of the Anatomy Department and the other belonged to the Zoo family group.

Baboon "Mussler" was born in the Anatomy Department on September 9, 1939, of a mother belonging to the species *Papio porcarius*. At the time of its birth the present housing facilities in the Anatomy Department were not yet completed and the mother was accommodated in a rather small cage. Our previous experience had shown that in such circumstances baby baboons could not be successfully reared. Sooner or later such infants were illtreated by their mothers and never survived for long.

Having determined at all costs to rear a baby baboon in captivity we de-

[1] Editor's note: Finger sucking in monkeys has been discussed by H. E. Kelsey, International Jour. Ortho. and Oral Surg., vol. 22, no. 11, 1936.

cided to separate the newly born infant from its mother. For two days Mussler was fed on artificial food but unfortunately the artificial diet proved to be unsatisfactory and the baby speedily went downhill. As a last resort we gave the baby back to the mother, who was then accommodated in a more spacious cage. Fortunately the baby was able to suckle and he thrived. The mother was nervous at all times, chiefly because she had been brought into captivity only a few days before the baby was born, and she had not had an opportunity for adapting herself to her new environment. Every time the cage was cleaned she desperately clutched the infant. Later when the attendant was cleaning the cage she even attempted to kill the infant by compressing it between her fore and hind limbs and kneading it roughly on the ground. It seemed that this baby baboon was destined to suffer the same fate that befell our previous infants and we decided once more to separate the baby from its mother. On the second occasion the infant was removed when it was 14 days old. On the very first day after this separation the baby commenced to suck its thumb (Pl. 1a). Later in the day, the big toe of the left foot was also given considerable attention. Toe-sucking apparently proved to be more attractive and thenceforth the toe-sucking habit became established.

In the early weeks of life Mussler did not move about much in his small cage and toe-sucking seemed to be his main preoccupation. This habit was practised mainly between feeds and only on rare occasions did he attempt to suck his toe immediately after a meal. When Mussler was 20 days old he began to show interest in his environment. He conducted numerous explorations in his cage and at the end of such ventures he sat in one corner and sucked his toe vigorously. On the 27th day his central incisors erupted, but toe-sucking was not in any way accentuated. As usual Mussler would always be found in the early morning lying on his side or leaning against a corner in the cage sucking his toe.

Feeding was usually conducted by means of a bottle and teat at 4-hour intervals. Before the next expected feed Mussler usually could be seen hugging his soft sleeping mat and, with eyes closed, rubbing his nose in the mat presumably searching for the nipple in the manner in which breast fed baboons usually search the fur of their mothers. At the end of this fruitless quest he would take up his toe and only the presence of the milk bottle would induce him to interrupt this activity.

There are a number of constant stimuli which provoked thumb-sucking in this young baboon. Frustration during play or feeding were especially potent in this respect. On one occasion he seized his bottle before the teat had time to cool and the painful stimulus promptly caused him to withdraw the bottle and to take up his big toe. It was only after some minutes that he could be induced to take up his bottle once more. Teasing the infant by periodically withdrawing his bottle during feeds excited toe-sucking. If frustrated while

a

c

b

d

PLATE 1

a. Mussler aged 14 days sucking his big toe of his left foot; b. Baby baboon of the Zoo group (*P. hamadryas*) clutching the fur of his father and searching for the nipple; c. Mussler at 6 months sucking his big toe of his left foot and holding a stick in his other foot and with both hands; d. Mussler at 6 months sucking his big toe of his left foot.

he was climbing over low obstacles he would refrain from further efforts and suck his toe.

Again, after playing in his box or chasing moving objects for variable periods

of time he would tire and suck his toe. Sometimes it would be possible to divert him from this habit by producing new interest; at other times, however, not even the presence of food could distract his interest from his toe.

Loud noises in the first weeks of life invariably excited toe-sucking, later, unless the noises were exceptionally sharp and loud, he would go about his business in an unperturbed fashion.

Dropping the infant and catching him just before reaching the ground caused him to scream and if after such an experience he was placed in his box he would promptly suck his toe. Later, however, he learned to enjoy this form of play and welcomed any attempt to be taken up and thrown about. At such moments he would make his pleasure felt by uttering soft expiratory sounds.

When Mussler took to eating solid foods he developed a liking for bananas, cheese, apples, and buttered bread. Even at 6 months it was easy to induce toe-sucking by showing but withholding these delicacies from him. This was possible even after he had forgotten to suck his toe for days. On one occasion he was being teased with a short stick and when he gained possession of it, he used it to elevate his foot to facilitate toe-sucking. This is illustrated in pl. 1, c, d. While toe-sucking, he performed a number of independent actions, such as holding the stick with one hand, scratching his posterior end with the other and watching at the same time the happenings in his immediate environment.

When Mussler was strong enough to run around and withstand changes in temperature he was taken from the warm room in which he had lived since birth to the roof where the colony is housed. For a long time the roof seemed to terrify him, and whenever he was taken outside he screamed until he saw that no attention was being paid to his complaints. He would then lie on his back and suck his toe until he was picked up and returned to his room.

When 6 months of age he was given a small female baboon companion. Toe-sucking became less and less frequent and now at 9 months it has ceased altogether. He still bears the ill effects of his former vice in the great flattening of his left big toe, which seems to have been the favored digit.

The second case of thumb-sucking occurred in one of the young of the family group at the Johannesburg Zoo. The mother was nursing an infant 4 weeks old. The subject in question was a female about 18 months old as shown in the register of births kept at the Zoo. The father was a big husky baboon with a huge grey cape hanging over his shoulders as occurs characteristically in all males of the species *P. hamadryas*.

The circumstances in which toe-sucking took place are most illuminating. It was late in the afternoon. The cage was strewn with untouched peanuts thrown in by interested visitors. As is customary just before sun down the male baboon sprawled himself on a beam suspended from the roof of the cage. The mother with baby clutching her fur proceeded to groom her overlord.

The 18 months old daughter alternately groomed the mother and the father. The daughter obviously lacked the interest or the concentration in these operations shown by the mother. While grooming the father, she had apparently been unduly rough and he scared her off by a threatening noise. She retired to the end of the beam close to the front of the cage, cocked her feet up against the wire and brought her face into contact with the dorsum of her feet. In this position she commenced to suck her big toe most diligently. Although this group had been under close observation for several months she was never seen to suck her toe at any other time.

DISCUSSION

The significance of thumb-sucking in children is largely dependent on the age at which this habit manifests itself. Langford (1939) groups thumb-suckers into three age groups, the infant up to 10 months, from 10 months to 5 years (pre-school child), and from 5 years to puberty.

The healthy new born infant will suck vigorously at almost any object. In the neonatal period thumb-sucking may be the persistence of the purely reflex action initiated at birth. There are a number of other circumstances, however, such as hunger and fatigue under which thumb sucking may be established.

Levy (*op. cit.*), and Gesell and Ilg (1937) have approached this problem from a physiological angle. Gesell and Ilg have emphasised the value of the mouth and lips as sensitive tactile organs and, in the early days, the human infant tends to explore objects by means of these organs. On account of the active movements of the arms and legs the fingers reach the mouth during these manipulations. Thumb-sucking is frequently seen in the human infant at this stage, which Langford has called the 'hand to mouth' reaction period. The disappearance of this type of thumb-sucking is said by Gesell and Ilg to be due to either the change in bodily structure which interferes with the hand to mouth reaction, or perhaps to the emergence of cortical control which inhibits the subcortically initiated movements of the arms.

Levy, however, states that the lips and mouth like the arms and legs require to be actively moved in early life. If human infants have not sufficient normal lip and mouth exercise then this lack is supplemented by thumb-sucking. Accordingly, Levy lays emphasis on a number of conditions which usually stimulate thumb-sucking in human infants. Where the milk flows too rapidly and too easily from the breast or bottle the baby is forced to curtail his feeding activities since he obtains food without much lip and mouth effort. Forced withdrawal of the breast or bottle at the termination of too short a period of time and increase in the intervals between feeds all tend to excite thumb-sucking. In all three of these situations the baby does not have sufficient lip and mouth exercises and this lack is supplemented by thumb-sucking.

New born baby baboons take the breast within an hour or two of birth. The mother plays no active part in directing her baby to the nipple. It is the most convenient posture for the mother to allow the child to suspend itself from her bosom. In this position the baby is able to feed comfortably. Sometimes, however, the baby is held upside down and then it will attempt to seek the breast by nosing around in the hair in the groin region. Baby baboons feed irregularly and frequently for the first 3 to 5 months of life. In the later months of infancy they feed at longer intervals and tend to mouth all manageable objects. Breast feeding continues at least for 6 months but the baby is almost completely weaned when about 8 or 9 months old when the full milk dentition has appeared.

Smooth objects, including the nipple in contact with the mouth, excite sucking movements in young infants. On one occasion the chain of a mother dangled over her chest. The infant, with eyes closed, nosed around in the hair in search of the nipple when by accident his nose came into contact with the large smooth links. They were promptly taken into the mouth and were mouthed for a moment before the infant once more searched for the nipple. That the infant tends to take up the nipple is due most certainly to the fact that it is smooth and bereft of hair. This has been proved in breast fed infants separated from their mothers and offered an artificial nipple firmly supported in a woollen or fluffy cloth. The baby rubs its nose all over the cloth. When it contacts a soft piece of rubber or other soft, smooth object provided for the purpose, it promptly begins to make sucking or biting movements. This experiment indicates that soft woolly objects simulating hair will tend to stimulate the infant to search for the nipple.

This response of the baby baboon to smooth objects facilitates no doubt the sucking of the big toe once it comes into contact with the mouth as is so easily possible when the baby lies in the flexed position with the feet clutching its own chest (pl. 1, a).

Even when some weeks old, if the infant is put on a woolly cloth, it tends to rub its nose in the cloth searching for the elusive nipple and, if by chance its mouth contacts its fingers or its toes, it makes an attempt to grasp them with its mouth.

One of the main reasons preventing the development of thumb- or toe-sucking in breast fed infants is the fact that the hands or feet of the baby are actively employed in clutching the mother. It is thus a physical impossibility for the toe or thumb to come anywhere near the mouth of the infant. Thumb- or toe-sucking can only become possible when the baby is emancipated partially or completely from its mother.

While it is idle to speculate on the causation of toe-sucking in baboons it seems most probable that three factors were responsible for thumb-sucking in Mussler, namely, the innate tendency to suck or bite, the presence of smooth objects in contact with the sensitive mouth and lips, and finally hunger. The

extreme degree of flexion encountered in the very young infant baboon doubtless facilitates the approximation of smooth toe or thumb to the sensitive lips and mouth.

Lip and mouth movements are originally excited in the young baboon by hunger. The hand to mouth reaction in the human infant may be conducive to thumb-sucking. In the extremely young infant baboon separated from its mother the almost tonic flexion of the body and the spontaneous clutching movements of hand and feet present at birth bring the hands or feet near the mouth. The baby baboon in quest of the nipple contacts the smoothe finger which simulates the nipple. The thumb or big toe is thus taken into the mouth. Later, however, other stimuli excite thumb-sucking. These same stimuli will cause breast fed babies to seek protection by taking up the nipple. Whenever breast fed infants are terrified they promptly clutch the hair of the mother and immediately search out the nipple which they eagerly bite or suck. One instance of this was particularly well illustrated when the infant baboon at the Zoo got into difficulties and the father took the baby in his arms. The baby thus pressed to its father's breast promptly sought out its father's nipples (pl. 1, b). In babies separated from their mothers the thumb or big toe takes the place of the nipple.

The second period during which thumb-sucking becomes accentuated in the human child is between the ages of 10 months to 3 or 4 years. Gesell and Ilg noted that a recrudescence of thumb-sucking occurred around the 14th or 15th month when trouble is experienced with teething. Although teething commences between the ages of 17 and 27 days it apparently does not accentuate toe-sucking in the baboons.

Langford states that in this second period, boredom, scoldings, frustration, especially when the child is learning to walk and talk, usually provoke thumb-sucking.

In the baboon 2 to 6 months old toe-sucking can also be excited by hunger, frustration, anger and loud noises. The baboon and the child therefore practice thumb- or toe-sucking under similar circumstances.

In the third period from 5 to 14 years during which thumb-sucking may occur in children this habit is regarded as an expression of emotional instability.

From the foregoing it is clear that thumb-sucking is not a reaction peculiar to human infants and children, but that it also occurs in the baboon. Many of the stimuli which appear to provoke thumb-sucking in the human child also operate in the baboon. Whether the Freudian interpretation, that thumb-sucking in the human child is a sexual activity, applies to the baboon is difficult to substantiate. Pleasure sucking in the baboon is not usually connected with an entire exhaustion of attention, and neither does it usually culminate in sleep. On the contrary the baboon can be diverted from toe-sucking by providing new objects of interest. In the young animal thumb-sucking was

especially noticeable in the morning before the first feed. It seems likely that toe-sucking in the baboon is not necessarily a sexual activity but rather related to some more fundamentally physiological process. Having learned, this form of behavior becomes quite useful to the young baboon when confronted by new situations that it cannot easily circumvent. In short, thumb-sucking in the baboon is the easiest way out of a difficult situation.

SUMMARY

Toe-sucking has been described in two baboons, one breast and the other bottle fed. Four factors are suggested as leading to the development of this habit in bottle fed infant baboons, namely, the tendency to bite or suck, the presence of smooth objects in contact with sensitive mouth or lips, hunger, and the liberation of the hands and feet normally used by breast fed infants in clutching the mother. In older baby baboons, loud and sudden noises, frustration, boredom, anger, and hunger may provoke thumb- or toe-sucking.

Stimuli that provoke thumb- or toe-sucking in baby baboons separated from their mothers tend to excite nipple sucking in breast fed infants.

Thumb- or toe-sucking in the baboon and the human infant are compared and evidence is presented to show that once the habit is developed this practice can be excited in both by similar stimuli.

I wish to express my indebtedness to Professor Raymond Dart for his advice and encouragement and to the National Research Council and Board (South Africa) for a grant made in aid of this investigation.

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SEX RATIOS AND WEIGHTS OF MUSKRATS (*ONDATRA ZIBETHICA ZIBETHICA*) FROM WISCONSIN

By Irven O. Buss

According to Errington (1940), "It has long been known that male muskrats may to a considerable extent be taken selectively by trapping in spring." His statement is substantiated by the findings of Marshall (1937) who found a spring sex ratio in Utah muskrats of 60.5 percent males to 39.5 percent females in a series of 491 individuals, and by the findings of Hatfield (1939) who found a spring sex ratio in Minnesota muskrats of 57.23 percent males to 42.77 percent females in a series of 484 individuals. Johnson (1925) gives the experiences of New York trappers stating that in the spring prior to April 10, "Only about 10 percent of their catch consists of females, which is due principally to their practice of not setting traps near muskrat houses."

There is less information on fall sex ratios of trapped muskrats and I know of no one who claims that selective trapping influences fall sex ratios. During the fall and early winter Marshall (*loc. cit.*) found only 48 percent males for 1,065 individuals. Errington (*loc. cit.*) found 52.3 percent males for 595 muskrats caught by the Iowa Conservation Commission from Round Lake, northwestern Iowa, in November, 1936, and December, 1936–38. "Of these catches, males comprised 55.1 percent of 463 young of the year, but only 42.3 percent of 132 adults, which ratios probably reflect differential spring mortality from natural causes in the absence of legal spring trapping." Neither Hartfield nor Johnson give any sex ratios for fall and early winter.

During the fall trapping seasons from November 15, 1939, to January 1, 1940, and from November 1, 1940, to December 1, 1940, I sexed 2,287 muskrats trapped from La Crosse, Pepin, and Dunn counties, Wisconsin.

Three methods were used in sexing these muskrats: (1) examination of external genitalia of dead muskrats, used when examining trappers' catches in the field before the muskrats had been skinned, (2) dissection and examination of the reproductive system, used on carcasses after trappers had skinned their catches, and (3) examination of stretched and dried muskrat pelts. All three methods were found to be valid.

Method (1).—Male muskrats have a urogenital papilla entirely surrounded with fur. The penis can be felt by using the thumb and forefinger at the base of the papilla. Female muskrats have a urinary papilla partly surrounded with fur. The vaginal region between the urinary papilla and the anal opening is without fur, and the vagina may or may not have an external opening. Examination of a series of females trapped in November, December, January, and February, showed that females having given birth to young may have their vaginal opening grown over by November. A female trapped on November 3, weighed 1321 grams, had a hyperemic uterus that showed

periodic pigmentation and periodic enlargement. The uterine horn measured 80 millimeters long, but the vaginal opening was sealed.

Method (*2*).—Dissecting exposed testes or uteri.

Method (*3*).—The dried pelt of a female muskrat, whether adult or juvenile, will show three pairs of mammae directly behind the fore legs and two pairs in front of the hind legs (see pl. 1). The mammae of fall-trapped pelts are more distinct than those of spring-trapped pelts, for the pink flesh of prime muskrats adheres to the pelt and tends to cover the mammae.

Table 1 gives the sex ratios for each period of time and locality from which the muskrats were trapped.

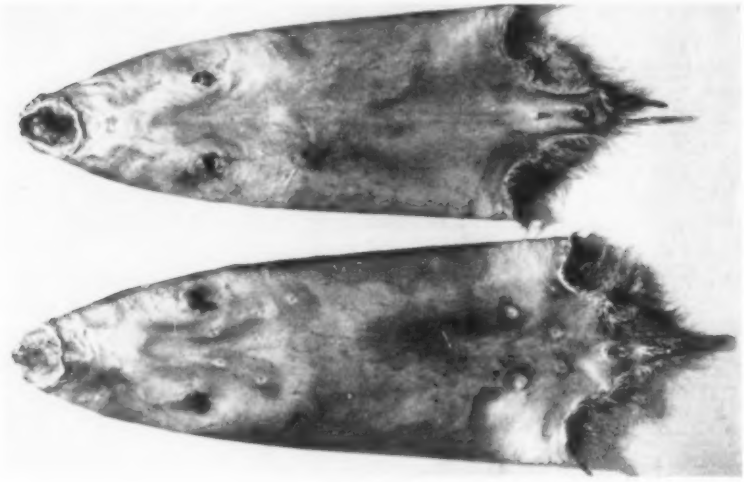

PLATE 1

Dried muskrat pelts, male (top) and female (bottom). Note the position of the seven pairs of mammae on the skin of the female; also, of the penis on the skin of the male.

The 85 muskrats trapped on the Chippewa River in Pepin County in 1939 and the 87 muskrats trapped from Lake Menomin in 1940 were first sexed by using method (1), then checked by using method (2), and finally a check was used on method (3) by having a fur dealer and a trapper sex these same rats by examination of their dried pelts. All three methods gave the same sex ratio.

It seems that selective trapping could not have influenced the sex ratios shown in Table 1, for the breeding season does not occur during the periods when these muskrats were trapped, and there likely would not be differential activity between sexes.

The difference in sex ratios between various localities suggests that there may be a natural cause for sex-selective mortality. The reasons for this mortality are not clear to me. Trapping regulations could not have caused the variation in sex ratios from Dunn County, for the laws apply to the county as a whole. I believe the 85 muskrats trapped from Pepin County in 1939 represent an entire colony. After these muskrats had been removed from a three-acre slough (draining into the Chippewa River) mild weather offered a good chance to trap any remaining stragglers, yet 150 traps set for over a week yielded no returns.

TABLE 1.—*Sex ratio of 2287 winter-taken muskrats in Wisconsin*

DATE	LOCALITY	MALES	FEMALES	TOTAL	PER CENT MALES
1939					
Nov. 18–Dec. 12	Pepin County, Chippewa River	62	23	85	73
Nov. 15–Jan. 1	La Crosse Co., Mississippi R.	902	317	1219	74
1940					
Nov. 1–Nov. 7	Dunn County, Tainter Lake	158	124	282	57
Nov. 6–Nov. 20	Dunn County, Mud Creek	109	79	188	58
Nov. 1–Nov. 4	Dunn County, Lake Menomin	63	24	87	72
Nov. 1–Dec. 1	Dunn County, at large	280	146	426	66
Totals		1574	713	2287	69

TABLE 2.—*Weights of 589 November-taken muskrats in Wisconsin*

DATE	LOCALITY	NO. OF MALES	AVE. WT. OF MALES	NO. OF FEMALES	AVE. WT. OF FEMALES
Nov. 1–Nov. 7	Tainter Lake	158	1024.2	124	1045.6
Nov. 6–Nov. 20	Mud Creek	109	1019.8	79	1003.7
Nov. 1–Nov. 4	Lake Menomin	53	1007.4	21	1095.9
Nov. 1	Dunn County at large	32	976.5	13	1222.9
Totals		352	1015.9	237	1057.9

I have often heard fur dealers and trappers say that they observed considerable local variation in the size of muskrats and that females were heavier than males. Stream or "crick rats" are supposed to be smaller than lake or "marsh rats." Johnson (*op. cit.*) agrees that there are local variations in size of muskrats and says that "among local trappers and handlers of raw furs the view is sometimes met with that the muskrats of one section or locality of the state are distinguished from those of another section or locality by rather positive differences in size. . . ."

While sexing the muskrats discussed above, I had opportunity to weigh 589 of them. Table 2 gives the weights of males and females from Dunn County during 1940.

The 237 females have an average weight advantage of 42 grams over the 352 males. The heaviest female weighed 1585 grams, while the heaviest male weighed 1644 grams. Both were caught during the first week in November (their fur was dry at the time of weighing).

The 188 muskrats from Mud Creek (a small meandering creek draining into the Chippewa River) averaged 1028.2 grams, while the 356 muskrats from Tainter Lake and Lake Menomin (both artificially-created lakes or ponds on the Red Cedar River) averaged 1033.3 grams, a difference of 5.1 grams in favor of the lake muskrats. This difference seems to be of no significance.

Acknowledgments are made to Stanley Olson, Helmer Mattison, and Arnold Buss of Menomonie, Wisconsin, for assistance during the 1940 trapping season, and to William Elder, University of Wisconsin, for help in making physiological examinations.

SUMMARY

The sex ratio of 2,287 muskrats trapped from Pepin, La Crosse, and Dunn counties, Wisconsin, during the fall and early winter of 1939 and 1940 showed 69 percent males or 2.2 males to 1 female.

Fall-trapped female muskrats having the vaginal opening sealed may easily be mistaken for males.

The weights of 352 males and 237 females from Dunn County in November, 1940, show that the males averaged 42 grams less than the females.

The weights of 188 muskrats from Mud Creek in Dunn County averaged 5.1 grams less than 356 muskrats from Tainter Lake and Lake Menomin in Dunn County.

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THE TECHNICAL NAME OF THE CHINCHILLA

By Wilfred H. Osgood

Mus laniger Molina (Saggio Stor. Nat. Chili, pp. 301–302, 1782) was described from tales of natives, notes, and memories after its describer had left Chile. There is no evidence that any specimens were in the author's hands at the time of writing nor at any other time. Since he coupled the native name *chinchilla* with it, however, it was accepted by various authors prior to 1829, who supposed it referred to the fur-bearing rodent then known in Europe only by incomplete market skins. In 1829, Bennett received complete specimens of the animal and observed living examples in the London zoo. He determined these to represent a new genus which he fully described and figured (Gardens and Menag. Zool. Soc., vol. 1, pp. 1–12, Oct. 1829). His account, although thorough and detailed, was semi-popular in nature and a more technical and more fully illustrated treatment was later issued (Trans. Zool. Soc. Lond., vol. 1, pp. 35–64, pls. 5, 7, 1835) in which he characterized the family Chinchillidae. His first paper bears a good woodcut of several chinchillas beneath which is the heading

"THE CHINCHILLA
Chinchilla lanigera"

Then follows a historical account and detailed description. No other specific name is mentioned and, although the name *laniger* is changed to the feminine form *lanigera* without mentioning Molina as authority, there is no doubt Bennett assumed that Molina's species might be the same as the one he had in hand. This is shown by his definite citation of Molina's name under his own in his later paper (p. 59). In doing this he may have been influenced by the general acceptance of the name by other authors, for he was clearly aware that Molina's description was defective. This is evidenced by the following extracts from his text: (p. 2) "the description given in his [Molina's] work added little of truth and much of error"; (p. 5) "it is impossible to place in his descriptions that implicit confidence to which his acknowledged good faith would otherwise entitle him"; (p. 7) "we have thus fortunately placed within our reach the means of correcting many of the errors into which former writers have fallen with regard to it." These statements might even justify the assumption that Molina's species was "doubtfully referred" or that it was a "species inquirendae" from Bennett's standpoint. Certainly they seem to border on it and perhaps deserve some consideration in judging the case.

Authors subsequent to Bennett, with some exceptions (*e.g.* Lichtenstein), have followed him in accepting Molina's name for the chinchilla, and the generic name *Chinchilla*, with the family name Chinchillidae derived from it, has been current in literature. In some cases (*e.g.* Palmer, Index Gen.

Mamm., pp. 181, 844, 1904) the *Mus laniger* of Molina is definitely stated to be the type of the genus *Chinchilla*. No very critical examination of Molina's description appeared until 1934 when Prell (Zool. Anzeig., vol. 108, p. 100, 1934) carefully analyzed it and concluded that it does not apply to the chinchilla; therefore, since the Chilean form was without any other name, he proposed to call it *velligera*. In a second paper (Zool. Garten, Leipzig, vol. 7, pp. 207–209, 1934) he discussed the case further and expressed the belief that Molina's *Mus laniger* applies not to the chinchilla but to the so-called false chinchilla or chinchilla rat, an animal belonging to a different genus (*Abrocoma*) and family. Assuming this conclusion to be correct, it would then follow that at least the specific name *laniger* would be used for an *Abrocoma*, and under some interpretations it might be argued that the generic name *Chinchilla* and the family name Chinchillidae should be transferred. However, Prell did not advocate this, but continued to use *Chinchilla* as historically applied and only made the suggestion that perhaps it should be legalized "als nomen conservandum." The case is a very intricate one with much room for difference of opinion. A ruling by the International Commission on Zoological Nomenclature, if one could be obtained, might have its advantages, but as the Commission is now inactive, such a ruling is scarcely to be hoped for. Since Prell has left the matter undecided, since the animal is an important one, and since other authors less familiar with the details concerned are likely to confuse the real issues, a thorough discussion of the case seems desirable.

Prell's contention that *Mus laniger* Molina does not apply to the chinchilla is thoroughly borne out by the facts. The reference of *Mus laniger* to *Abrocoma*, however, is doubtful and, although Prell's argument for this is quite thorough and specific, it is simpler and less confusing to take Molina's description for what it obviously is, a mixture of names, facts, and memories of reports from aborigines relating to no less than four generically different animals. In other words, *Mus laniger* is vague, composite, and unidentifiable. This is practically admitted by Prell (*l.c.*, p. 207) who says this description has caused difficulty principally "weil sie nicht einheitlich ist". It is scarcely justifiable to analyze Molina's description as if it were that of a modern author, since it is well known that he had no access to specimens and that his work was prepared from notes and memories after his residence in Chile had terminated. He, himself, states in beginning his accounts of the mammals that his reports from native sources were often very meager and that he found himself obliged to omit various species because of insufficient data although he believed them to exist. Further proof of his uncertainty is the omission in his second edition of some of the animals described in the first.

Mus laniger is not the only case in which Molina's descriptions are composite; several others are in the same category. *Castor huidobrius* is perhaps the best example. Under the vernacular name *guillino*, which should refer

exclusively to an otter, he describes an animal with dimensions and habits of an otter and the dentition of a rodent. He places it in the genus *Castor* and mentions the character and use of its fur. Immediately following it, he gives a good description of the coypu, and elsewhere he satisfactorily describes and names an otter. So it is evident neither was intended in this place. Obviously the name *huidobrius* cannot be used either for an otter or a coypu since it is plainly a combination of the two.

It is scarcely conceivable that Molina had no knowledge of such a common and important animal as the chinchilla, but it is very easy to believe that in attempting to describe it he introduced hearsay matter applying to other animals, none of which he had in hand while writing. Considering his description from this viewpoint, it appears that he has used the vernacular name *chinchilla* much as he did *guillino* and that under it he has confounded the true chinchilla, the mountain viscacha, the chinchilla rat, and perhaps the degu (*Octodon*). Aside from the peculiar circumstances applying to Molina, it is to be noted that other authors also frequently confused these animals. Even as careful an observer as Lichtenstein, in describing and figuring his *Eriomys chinchilla*, mis-stated the number of toes.

Perhaps the most serious objection to the application of *Mus laniger* to *Abrocoma* is the fact that there is nothing in Molina's text that might be taken to indicate *Abrocoma* which does not apply equally well to *Octodon*, an animal which occupies the same region as *Abrocoma*, has approximately the same dimensions, and differs from it externally mainly in minor points not mentioned by Molina. The fifth front toe of *Octodon*, which is not present in *Abrocoma*, is small and rudimentary, not noticeable without careful examination and scarcely needs to be considered in this connection. Certainly Molina had no knowledge of any distinction for he describes the degu as having the same number of toes as the chinchilla. If complete accuracy of description were demanded, it would scarcely be possible to accept any of Molina's names, but in most cases there is no question as to the animal intended and minor misstatements have been overlooked. Where he confuses several animals under one name, however, this cannot be done, since any attempt to evaluate the description on a proportionate basis leads to hopeless difference of opinion. Therefore, the only practical course is the suppression of names based on such so-called descriptions. In fact, with few exceptions, it is only descriptions of this kind that can justifiably be called "unidentifiable". Those that are merely inadequate are in a different category and frequently are not unidentifiable from the contemporary standpoint.

In the case of *Mus laniger* the common name and some of the general matter refer exclusively to the true chinchilla; the ashy color (cenerino) might apply to any of the animals concerned; the soft wool (lana) of spinning length and the reference to its use for making cloth apply to the viscacha; the length of 6 inches applies best to *Octodon*, next to *Abrocoma*, next to *Chinchilla*, and is

quite impossible for *Lagidium* (length of head and body in *Octodon* is 6–7½ inches, in *Abrocoma*, 7½–9 inches, and in *Chinchilla* 9½–11 inches); the small ears likewise apply most to *Octodon* (in *Abrocoma* the relative size of the ears is not greatly less than in *Chinchilla*); the pointed ears applies to none; the tail of moderate length covered with silky hair applies equally to *Octodon* and *Abrocoma;* the number of toes (4 in front and 5 behind) is exact only for *Abrocoma*, but the rudimentary toes in both *Octodon* and *Chinchilla* are often overlooked. This exhausts the purely descriptive matter provided by Molina, and his statements regarding habits offer nothing of consequence.

If we accept the conclusion that Molina's *Mus laniger* is wholly unidentifiable there remains the question as to what is the type of Bennett's genus *Chinchilla*. What Bennett actually did was to provide a generic name and description for an animal not previously named either as to species or genus. In doing so, he mentioned the combination *Chinchilla lanigera*, obviously derived from Molina's *Mus laniger*, but nowhere does he express definite belief that his animal and Molina's are the same. On the contrary, his reference is doubtful and qualified; therefore, subsequent designation of *Mus laniger* as the type of this genus is unjustified not only because it is unidentifiable but also because it was a "species inquirendae". Both the International Code and the A.O.U. Code are specific that such a species cannot be selected as type of a genus.

The genus was monotypic from Bennett's standpoint and, although three forms (Chilean, Peruvian, and Bolivian) are now recognized, they are so closely related that subspecific status for all of them is not improbable. However this may be, it is obvious that the type *must have a name based on the animal described by Bennett*, that is, the Chilean form as at present understood. This excludes the first specific name properly applied to a true chinchilla which is *Eriomys chinchilla* Lichtenstein (Darst, neu o. wenig. bekannt. Saugeth., 2 pages and pl. XXVIII, 1829) based on the Peruvian form. Evidence is not wholly conclusive as to the priority of *Chinchilla* over *Eriomys*, but the first author to consider the question (Shaw, Nat. Hist. Mamm., vol. 2, p. 233 footnote) has definitely given preference to *Chinchilla* on the grounds that its description is more complete and more accurate. The generic name *Eriomys*, therefore, is a synonym of Bennett's *Chinchilla* and the specific name *chinchilla* is valid for the Peruvian form but not available as type of the genus *Chinchilla*, in spite of the tautonymy, and in spite of its priority. The combination *Cricetus chinchilla* was used by Fischer in 1814 (Zoognosia, vol. 3, p. 55), but only as a substitute for *Mus laniger* and it does not necessarily affect the later use of the name *chinchilla* by Lichtenstein. *Chinchilla lanigera* as used by Bennett is, at best, also to be regarded as a substitute for *Mus laniger* and, although it is not an exact homonym, any attempt to give it status with Bennett as authority is likely to be futile. An earlier reference to Bennett's material is found in the Zoological Journal (vol.

4, p. 317, 1828) where Yarrell uses only the vernacular name Chinchilla but significantly places a question mark after the name *Mus laniger* Molina which he refers to it, thus indicating the uncertainty about this name which prevailed at the time.

Owing to the continued mistaken use of the specific name *laniger*, the Chilean chinchilla had no other name applied to it until 1934 when Prell (Zool. Anzeig., vol. 108, p. 100) called it *Chinchilla velligera* and plainly stated that the name was intended to apply to the animal described by Bennett.

This, therefore, is the only name providing the requirements for a type for the genus *Chinchilla* if *Mus laniger* is removed from consideration. It might be contended that the type should be the species first referred to the genus after its characterization (see Opinion 46). This, however, would bring us to a species (or subspecies?) "not included under the generic name at the time of its original publication" (i.e. the Peruvian form rather than the Chilean), for in this case it is plainly evident what species is involved even though it hadn't at the time received a name. Theoretically or nomenclaturally it must be assumed that the Chilean and Peruvian forms are different species.

If *Mus laniger* be suppressed or excluded as a possible type of *Chinchilla*, considerable confusion would be avoided. In fact nothing would be lost except the specific name *laniger*. The family name Chinchillidae would stand as at present. The Chilean form, if proved to be only subspecifically different from the Peruvian, would be *Chinchilla chinchilla velligera*. There would be no confusion of technical and vernacular names, no change in the status of *Abrocoma*, and no further speculations as to the interpretation of Molina's equivocal text.

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THE SHORT-TAILED SHREWS (CRYPTOTIS) OF TEXAS

By William B. Davis

A series of 16 intact skulls of *Cryptotis* retrieved from barn owl pellets collected from a roost near Eagle Lake, Colorado County, Texas, (see Davis, 1938) and 23 additional specimens (skins and skulls) from Texas, have offered an opportunity to study the variations in a population of this shrew from a single locality and also to investigate the relationships of the two supposed species, *C. parva* (Say) and *C. berlandieri* Baird, recorded from Texas (Merriam, 1895; Bailey, 1905).

AGE VARIATIONS IN SKULLS

Based upon the amount of wear exhibited on pm^4, the 16 skulls from Colorado County fall naturally into three classes, namely, (1) those with con-

siderable wear, hence, seemingly fully adult animals, (2) those with a medium amount of wear (probably subadult), and (3) those with little or no wear evident. Measurements of individuals in these three classes are presented in Table 1.

That the skulls of subadults are not appreciably different in size from those of adults, a circumstance of importance from a comparative viewpoint, is evident from Table 1. Furthermore, the range of individual variation in these two groups is almost identical. Young individuals with unworn pm^4,

TABLE 1.—*Cranial measurements, in millimeters, of 16 Cryptotis from near Eagle Lake, Colorado County, Texas*

AGE	LENGTH OF SKULL	MAXILLARY BREADTH	PALATAL LENGTH	POST PALATAL LENGTH	INTERORBITAL BREADTH	DEPTH OF EXCAVATION IN M^1
Old	17.3	5.6	7.5	7.8	3.7	.20
	16.9	5.4	7.4	7.6	3.8	.20
	17.4	5.4	7.7	7.8	3.7	—
	17.2	5.4	7.3	8.3	3.7	.15
	17.2	5.4	7.3	8.3	3.5	.20
Average	17.2	5.4	7.4	8.0	3.7	.19
Subadult	17.0	5.1	7.2	8.2	3.5	.20
	17.2	5.6	7.5	7.8	3.7	.20
	17.0	5.4	7.4	8.2	3.7	.15
	16.8	—	7.3	8.1	3.6	.20
Average	17.0	5.4	7.35	8.1	3.6	.19
Young	—	5.3	7.5	8.3	3.5	.20
	16.3	5.4	7.1	7.5	3.6	.15
	16.5	5.0	6.8	7.9	3.5	.10
	16.5	5.3	7.0	7.8	3.7	.20
	16.5	5.2	7.2	8.0	3.7	.15
	16.4	5.4	7.0	7.7	3.7	.15
	—	5.3	—	7.8	3.6	.20
Average	16.4	5.25	7.0	7.9	3.6	.16

however, clearly segregate from the adults and subadults. The length of the skull in young individuals is noticeably less, but the ratio of length of skull to maxillary breadth is practically the same (32 in young, 31 in adults), indicating that as the skull increases in length it also increases in breadth. The demarcation between young and adults is best indicated in figs. 2 and 3.

The chief difference distinguishing *C. parva* and *C. berlandieri* allegedly lies in the depth of the excavations in the posterior borders of m^1 and m^2 (Merriam, 1895). Of interest in this connection is the fact that a tendency toward a

deepening of these excavations with age is seen in the specimens from Colorado County, but statistically the observed difference is not significant. The fact that considerable individual variation in this character does occur in a population from a single locality, however, appears to be important. Young animals on the average have an excavation 0.16 mm in depth; in adults the

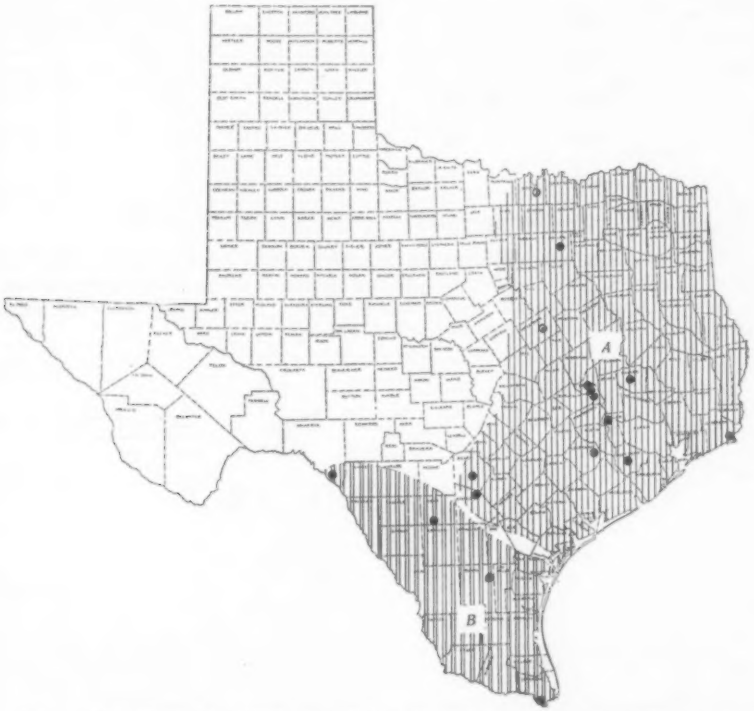

FIG. 1. Map illustrating the known distribution of *Cryptotis parva* in Texas. A.—*Cryptotis parva parva*, B.—*Cryptotis parva berlandieri*. Solid circles represent localities whence specimens have been examined; open circles, localities reported in the literature.

depth averages 0.19 mm. That this association with age might be due to chance is suggested by additional skulls, both adults and young, from a number of other localities in Texas. In these specimens no correlation of the depth of these excavations with age or with geographic position seems to exist. This feature needs further study, but many more specimens are needed before reliable conclusions can be reached.

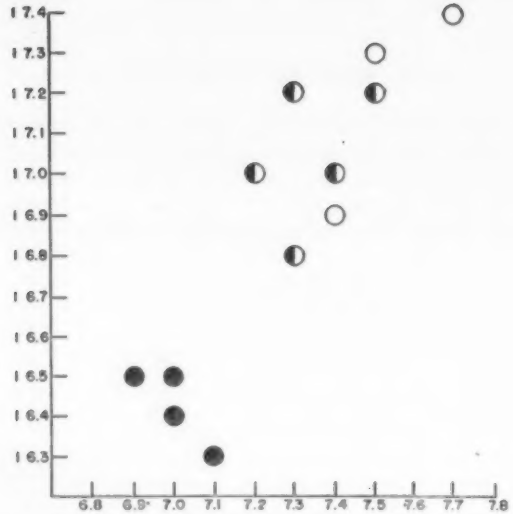

FIG. 2. Scatter diagram illustrating the segregation of *Cryptotis parva parva* from near Eagle Lake, Texas, on the basis of age classes when the palatal length (abscissa) is plotted against the length of the skull (ordinate). Solid circles represent young animals; half-solid circles, subadults; open circles, adults.

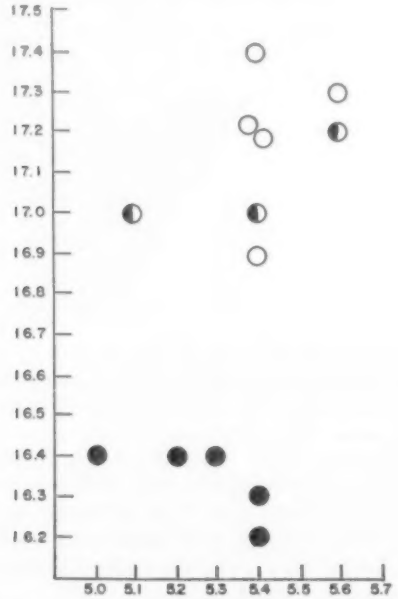

FIG. 3. Scatter diagram illustrating the segregation of *Cryptotis parva parva* from near Eagle Lake, Texas, on the basis of age classes when the maxillary breadth (abscissa) is plotted against the length of the skull (ordinate). Symbols as in fig. 2.

GEOGRAPHIC VARIATIONS IN SKULLS

Specimens from Huntsville, Bryan, College Station, Hempstead, Wellborn, Richmond, Eagle Lake, San Antonio, Pleasanton, and Brownsville exhibit few, if any, signigicant geographical variations, except in the length of the palate relative to the post palatal length (fig. 4). In this respect the specimens

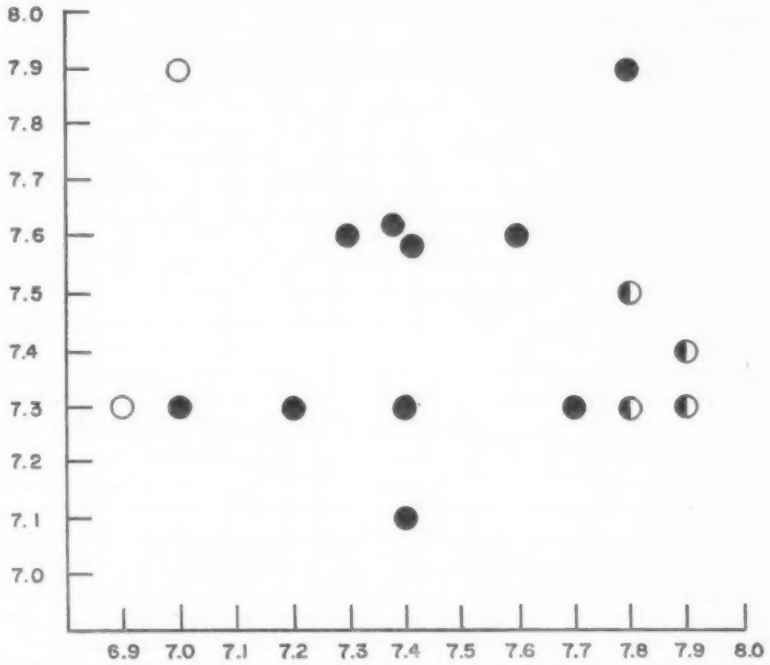

FIG. 4. Scatter diagram illustrating the slight geographic segregation of *Cryptotis parva* in Texas when the post-palatal length (abscissa) is plotted against the palatal length. Open circles represent young individuals from San Antonio and Whiterock (Dallas Co.) (referred to *C. p. parva*); half-solid circles, specimens from the Rio Grande Valley (referred to *C. p. berlandieri*); solid circles, specimens from southeastern Texas (referred to *C. p. parva*).

segregate weakly into three geographic groups: (1) those from the lower Rio Grande Valley, in which the palatal length is consistently shorter than the post palatal length (7.35 mm as compared with 7.9 mm), (2) those from the vicinity of San Antonio, and Dallas, which are young, in which the reverse condition is true (7.5 mm as compared with 7.0 mm), and (3) those from all other localities in which these two parts of the skull generally are equal

in length, or nearly so (average 7.5 mm as compared with 7.6 mm). A study of Table 2 reveals, however, that a shortening of the posterior part of the skull is evident in certain specimens (both old and young) from southeastern Texas, but not to the same extent exhibited in specimens examined from the San Antonio and Dallas areas.

A single specimen from Del Rio, at the upper end of the lower Rio Grande Valley, is considerably larger than specimens from Brownsville, but in other respects it is similar.

TABLE 2.—*Measurements, in millimeters, of 18 specimens of Cryptotis from Texas*

LOCALITY	SEX AND AGE	TOTAL LENGTH	LENGTH OF TAIL	LENGTH OF HIND FOOT	LENGTH OF SKULL	MAXILLARY BREADTH	CRANIAL BREADTH	PALATAL LENGTH	POST PALATAL LENGTH	INTER ORBITAL BREADTH	DEPTH OF EXCAVATIONS IN m^1
Brownsville	♀yg	75	13	10.5	—	5.2	7.9	7.4	—	4.0	.10
"	♀sub	80	18	11.0	17.0	5.5	8.2	7.3	7.8	3.8	.20
"	♂yg	80	18	11.0	16.8	5.3	—	7.3	7.9	3.8	.15
Del Rio	♀sub	87	19	11.5	17.1	5.8	8.5	7.4	7.9	3.8	.15
Dilley	?ad	68	16	10.5	17.0	4.9	8.0	7.5	7.8	3.8	.20
San Antonio	?yg	—	—	11.0	—	4.8	—	7.9	7.0	—	.15
Pleasanton	♂yg	76	18	10.5	16.5	4.7	7.3	7.3	6.9	3.4	.15
Whiterock	♂yg	74	13	10.9	16.8	4.9	7.8	7.3	7.0	3.6	.20
Bryan	♂ad	80	15	11.0	16.9	5.3	7.7	7.6	7.4	3.6	.10
College Station	♀sub	82	16	11.0	16.5	5.4	8.0	7.3	7.7	3.7	.20
" "	♀ad	79	15	10.0	16.7	5.1	8.2	7.1	7.4	3.9	.15
" "	♂yg	75	18	10.5	16.5	5.2	7.8	7.3	7.4	3.6	.20
" "	♂ad	79	21	11.0	17.0	5.4	8.2	7.6	7.6	3.8	.15
" "	♀yg	84	22	11.0	17.5	5.5	7.8	7.9	7.8	3.9	.15
" "	♂yg	88	18	11.0	16.8	5.5	7.9	7.4	—	3.8	.20
Wellborn	♀yg	68	17.5	10.5	16.8	5.2	7.9	7.6	7.3	3.5	.15
Hempstead	♂ad	81	17	11.0	16.3	5.5	7.8	7.3	7.2	3.8	.15
Richmond	♂ad	84	19	11.0	17.0	5.6	8.3	7.6	7.4	3.8	.15
Huntsville	?yg	68	17	9.0	17.0	4.9	—	7.3	—	3.7	.20

No geographic segregation of the specimens available to me can be made on the basis of the depth of the posterior excavations in m^1 and m^2. Specimens from each locality whence a series is available vary considerably in this respect.

GEOGRAPHIC VARIATIONS IN EXTERNAL FEATURES

Contrary to the statement by Bailey (1905) that *berlandieri* is slightly larger and paler than *parva*, I am unable to detect any constant geographic variations in these features. Although the three specimens from Brownsville are lighter colored than most specimens from elsewhere in the state, the light coloration can be matched in specimens from several localities in eastern Texas. The largest specimen from the lower Rio Grande Valley (Del Rio)

has external measurements in millimeters as follows: 87–19–11.5. These are nearly identical for a specimen from near College Station (central eastern Texas): 89–18–11. In fact, the average measurements of four specimens from the Brownsville area are nearly identical with the measurements of a series of eight specimens from near College Station (80–17–11 as compared with 80–17.9–10.5).

DISCUSSION

Assuming that specimens of *Cryptotis* from the southeastern parts of Texas are referable to *parva* (Merriam, *op. cit.*; Bailey, *op. cit.*), it becomes evident from this study that the characters useful in separating the shrews in the Brownsville area from those in that portion of the state outside the bounds of the lower Rio Grande Valley simmer down to three, namely, the average shorter palate, the longer post-palatal region of the skull, and the slightly lighter, less brownish coloration. These characters obviously are not trenchant, as a distinct tendency toward a long post palatal region is evident in several specimens from southeastern and eastern Texas. The reversed condition of long palatal length and short post-palatal length observed in specimens from San Antonio, Pleasanton, Whiterock, Bryan (1 specimen of 10 examined from this vicinity), Wellborn, Hempstead, and Richmond correlates neither with geographic position nor with age. The general tendency, then, in the region outside the Lower Rio Grande Valley is toward a relative shortening of the posterior part of the skull at the expense of the anterior part, but in certain specimens from Brazos County the opposite condition is found. Several specimens from this southeastern region of the state are as light colored as specimens from Brownsville, although the majority are a darker brown. For these reasons the name *berlandieri* in my judgment should be considered a geographic race of the earlier described *parva*. On this basis these two races in Texas occupy the ranges outlined on the accompanying map.

Acknowledgments are due the following individuals who loaned specimens in their care for this study: Dr. H. H. T. Jackson, U. S. Fish and Wildlife Service; A. J. Kirn, Somerset, Texas; P. B. Bole, Jr., Cleveland Museum; Dr. H. E. Anthony, American Museum of Natural History; F. W. Miller, Dallas Museum of Natural History.

Specimens examined (**Cryptotis parva parva**): Total number, 34, as follows: *Walker County:* Huntsville, 1 (Texas Cooperative Wildlife Collection). *Brazos County:* College Station, 9; 2 mi. S Bryan, 1; 5 mi. W Wellborn, 1 (all in Texas Coop. Wildlife Coll.). *Waller County:* Hempstead, 1 (Biol. Surv. Coll.). *Colorado County:* 6 mi. N Eagle Lake, 16, skulls only (Texas Coop. Wildlife Coll.). *Victoria County:* Victoria, 1 (Cleveland Mus.). *Atascosa County:* 9 mi. E Pleasanton, 1 (A. J. Kirn). *Bexar County:* San Antonio, 1 (Amer. Mus. Nat. Hist.). *Dallas County:* Whiterock, 1 (Dallas Mus. Nat. Hist.). Additional records: *Cooke County:* Gainesville (Bailey, 1905: 28). *McLennan County:* Waco (Strecker, 1924: 11). *Jefferson County:* Hog Island (Davis, 1940: 213).

Cryptotis parva berlandieri: Total number, 5, as follows: *Cameron County:* Brownsville, 3 (2 in Biol. Surv. Coll., 1 in A. J. Kirn Coll.). *Val Verde County:* Del Rio, 1 (Biol. Surv. Coll.). *Frio County:* Dilley, 1 (Texas Coop. Wildlife Coll.). Additional records: *Duval County:* San Diego (Merriam, 1895: 20).

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NEACOMYS FROM NORTHWESTERN SOUTH AMERICA

BY BARBARA LAWRENCE

Study of the genus *Neacomys* was prompted by finding, in a small series of skins of fairly uniform size from near Archidona in Eastern Ecuador, one distinctly smaller individual suggesting the occurrence in a given area of two distinct species differing primarily in size. The material at hand was not sufficient to show the possible range of variation of individuals of the same race taken in one place, and I am grateful to Dr. Wilfred H. Osgood of the Field Museum of Natural History, Dr. H. E. Anthony of the American Museum of Natural History, Dr. Lee R. Dice and Dr. Emmet T. Hooper of the University of Michigan Museum of Zoology, and Dr. Stanley C. Ball of the Peabody Museum of Natural History at Yale for the loan of additional specimens, a total of about 77.

While past studies of this group have leaned more towards distinguishing geographically separated, but closely related forms, the specimens at hand indicate that the distributional picture in northwestern South America is rather different. Here, in the more northerly part of their range, a large and a small species of this genus exist side by side; farther south only the large one has been recorded. The latter, *Neacomys spinosus*, is by far the more common and may be divided into two closely allied races based principally on average differences in size: *Neacomys spinosus spinosus* in Peru and *Neacomys spinosus carceleni* in Ecuador and Colombia. The smaller species, which has been taken with *carceleni* in a number of places, should be called *Neacomys tenuipes*.

Externally *Neacomys spinosus* may be separated from the smaller species, *Neacomys tenuipes*, by its larger size and longer hind foot, with a small, external heel pad always present. The skulls of the two species show no pronounced differences in proportion, although *spinosus* is the larger with a longer tooth row.

Names of colors in quotation marks are as in Ridgway's Color Standards and Color Nomenclature, 1912. Measurements of hind foot were taken by the author.

NEACOMYS SPINOSUS SPINOSUS (Thomas)

Hesperomys (Calomys) spinosus Thomas, Proc. Zool. Soc. London, p. 105, 1882. Huambo, Peru.

Neacomys spinosus spinosus was originally described from two specimens taken at Huambo, Peru. Skull measurements and the length of the hind foot (over 22 mm in both specimens) make it clear that the name was given to a member of the large species. The foot pads are described as small but prominent with no mention of the absence or obsolescence of the external heel pad and both specimens had dark patches on the metatarsals, characters that, although not conclusive by themselves, afford good additional evidence. Variation in color of the ventral surface is already noted in this earliest description, as are the gray bases of the hairs.

As examination of the type was impossible and no topotypical material was available, three specimens from Moyobamba and Poco Tambo have been considered typical. Dr. Osgood who collected them and is familiar with the country from which they come states in a letter that they are "from the region of the type locality of *spinosus*. This locality, Huambo, is some fifty miles away and about the same altitude." These three specimens are particularly interesting as the one from Moyobamba is an old male with the teeth so worn that the inner reentrant lobe on the second upper molar has been obliterated. The two much smaller ones from Poco Tambo are obviously young-adult animals; in one the cusps of the upper molars are still sharply conical, in the other the tops have started to wear off so that the looping of the enamel folds is beginning to be apparent. Further, the Moyobamba individual has the interorbital region broader with somewhat sharper supraorbital ledges and the braincase is proportionally longer and flatter, that is to say, a transverse line across the middle of the parietals is less domed. With only these two growth extremes to study, these differences might appear to have sub-specific importance if it were not for the long series collected at the Inca Mines by Mr. H. H. Keays [this locality is erroneously referred to as Juliaca by J. A. Allen in his first mention of Mr. Keays's series (Bull. Am. Mus. Nat. Hist., vol. 13, p. 222, 1900; for a correction see *ibid.* vol. 14, p. 41, 1901)]. This series furnishes good evidence of intergradation between two other such extremes.

Actual differences in skull proportion between old and young adult individuals of this series, as shown by reducing standard skull measurements to a ratio, are not great. Previous accounts of this species have been supplemented in this paper by a list of measurements and outline drawings, the object being principally to call attention to the extremes of variation that may be attained in individuals living in the same place. When differences in proportion seemed more significant than actual differences in measurement, ratios have been used as a basis of comparison. By such methods it has been determined that the Inca Mines series has the braincase on the average slightly wider in proportion to the total length than does the series of *carceleni* from Curaray, Ecuador, while the relation of width of braincase to interorbital width does not show any average difference in the two races. Furthermore, the interorbital width in the former is slightly greater in comparison with the length of the nasals than in the latter. Other such comparisons showed even less difference between the two races.

Separation of the forms of *Neacomys* on the basis of color characters is extremely difficult owing to the wide range of variation, not only in intensity of tone but also in hue. J. A. Allen (Bull. Am. Mus. Nat. Hist., vol. 31, p. 82, 1912) first mentions this with reference to the Inca Mines series. His description is good and detailed. The color notes I have added for the same series are for the purposes of comparison. The adult from Moyobamba has the back "tawny" heavily lined with black in the center, the sides are paler, less heavily lined, and gradually shade into a "light ochraceous-buff" lateral line. On the ventral surface the hairs are between "marguerite yellow" and "ivory yellow" all the way to the base on the throat and inguinal region; elsewhere they are faintly gray at the base. The dorsal surfaces of the feet are covered with silvery hairs, with, on the hind feet, a faint dark spot at the base of the toes. The tail is dark except for the basal third, which is whitish. The specimens from Poco Tambo have the bright tips of the hairs more yellow, less orange, and, except for the chin where the hairs are white to their bases, the ventral surface has the hairs prominently gray-based and tipped with "warm buff". Both types of coloring can be matched in the long series from the Inca Mines. Color of the ventral surface in this series varies from faintly creamy, with only a trace of gray at the bases laterally, to "ochraceous-buff" only slightly paler than the lateral line with the gray bases so pronounced as to give the belly a grayish cast. Color of the fore-arms is also variable; in a few the outer and ventral surfaces are entirely "hair brown" except for a few pale-tipped hairs on the outer side of the wrist; the other extreme has a sprinkling of bright-tipped hairs on the outer side of the fore-arm and on the ventral surface the "ivory yellow" of the belly extends in a broad band to the feet. This continuation of the pale ventral color on to the lower side of the fore-arms is by far the commonest type of coloring. Color of the ventral surface of the hind legs is, in general, the same as that of the sides and more or less

bright as the sides vary. The fore feet are scantily covered with a variable sprinkling of pale and dark hairs. Color of the hind feet differs much individually. In some it is "ivory yellow" with the dark spot at the base of the toes reduced to a dozen or so only slightly darker hairs; in others the patch is pronounced and sometimes extends as a stripe along the outer side of the metatarsals; some have the pale hairs verging on "warm buff". In general the feet are whiter distally, more ochraceous towards the ankle; one specimen has the feet entirely dark except for a tiny cluster of "ochraceous-buff" hairs at the proximal end of the metatarsals. In all the specimens examined the tuft of bristles at the base of the claws is silvery white while the toes themselves are, for the most part, thinly sprinkled with silvery hairs, although in some specimens these hairs are darker. Thus will it be seen that foot color is not a consistent character on which subspecific distinction can be based. Age differences in color are not striking. In the two Poco Tambo specimens the grayish bellies may be an age character; in the Inca Mines series this correlation does not hold. The amount of gray at the base of the hairs in the latter shows considerable variation. In all except one there is at least a trace of dark basally in the mid-ventral line. All of them have a patch of hairs on the chin, sometimes of considerable extent, sometimes reduced, that is white to the base.

Additional specimens, all from Peru, include three from the Rio Cayumba that average whiter on the ventral surface but are otherwise indistinguishable from the more brightly colored ones of the Inca Mines series. One from Pozuzo is also pale-bellied, while one from Utucuyacu and another from Pomara have the ventral surface washed with pale tones of "ochraceous-buff." All these should, I think, be called *Neacomys spinosus spinosus*.

A study has also been made of the bacula of these species. Unfortunately in the Peruvian specimens only one was found; from the series of *carceleni*, particularly those collected by the Olalla brothers at Curaray, a number were dissected out and two were found in the series of *tenuipes*. The expectation was that those of the races of *spinosus* would be similar and that of the small species might have some distinctive traits. Curiously, the baculum from the Inca Mines animal was the smallest of all, very delicate and slender, with the basal portion gradually flaring laterally but not bulbous. The specimen appears to be fully adult although the teeth are only beginning to wear. The bacula in a series of *carceleni* are rather uniform in size, much larger than in *spinosus* and with the basal portion much expanded, especially dorsally. This portion is also formed of spongier bone than in either of the two other races examined, but the gradual, rather than abrupt, lateral flaring is similar to that of *spinosus*. The baculum of *tenuipes* is intermediate between those of the two races of *spinosus* both in size and in dorso-ventral expansion of the base, although when seen from the dorsal side the lateral flare toward the base is somewhat more abrupt than in either of the others. All three of them have the cartilaginous tip trifid with the central prong the longest. There is a cer-

tain amount of individual variation in size and length of these branches and in their relation to each other.

Measurements. Measurements of the series from the Inca Mines, Peru, are given in the following order: extremes and average (in parenthesis) for the males, followed by the same for the females. *Cranial:* Total length, 22.3–24.3 (23.35), 21.6–23.8 (22.9); basal length, 17.2–19.3 (18.4), 17.5–19.0 (18.29); length of nasals, 7.8–9.3 (8.75), 8.0–9.5 (8.68); zygomatic width, 11.7–13.0 (12.25), 11.7–12.8 (12.23); width of braincase, 10.7–11.45 (10.99), 10.7–11.4 (10.97); mastoid width, 9.2–9.7 (9.57), 9.2–9.9 (9.54); interorbital width, 4.4–4.9 (4.56), 4.2–4.75 (4.46); length maxillary tooth row, 3.0–3.3 (3.14), 3.0–3.25 (3.09); length mandibular tooth row, 3.25–3.5 (3.4), 3.15–3.45 (3.33); anterior width across molars, 4.35–4.75 (4.6), 4.35–4.8 (4.63); posterior width across molars, 4.1–4.5 (4.34),

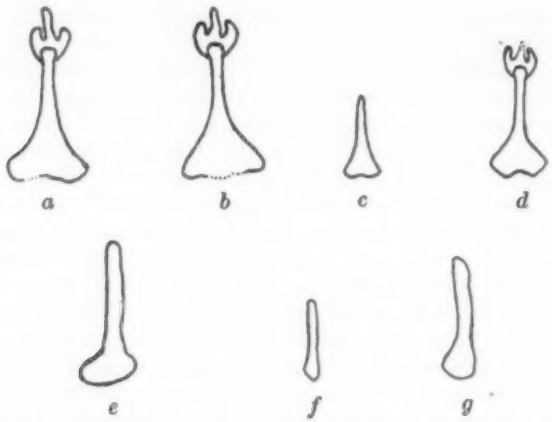

FIG. 1. Dorsal aspect of bacula of: a, A. M. N. H. 71535, b, A. M. N. H. 71516, both *Neacomys spinosus carceleni* from Curaray, Ecuador; c, *Neacomys s. spinosus*, A. M. N. H. 16518, from Juliaca, Peru; d, *Neacomys tenuipes*, A. M. N. H. 71540, from Curaray, Ecuador.

Right lateral aspect of bacula of: e, A. M. N. H. 71516, f, A. M. N. H. 16518, g, A. M. N. H. 71540.

4.05–4.65 (4.34); ratio of total length of braincase to its width, 45–50.5, (47.3), 46–50.5 (47.9); ratio of width of braincase to interorbital width, 40.5–45 (42.4), 38.4–43 (40.6); ratio of anterior to posterior width across molars, 91.5–96 (94.5), 90.5–97 (93.8). *External:* Hindfoot, 22.4–24.35 (23.23), 21.75–23.25 (22.59).

Measurements of three additional specimens from Peru are given in the following order: Moyobamba, male, F. M. 19360; Poco Tambo, male, F. M. 19690, female, F. M. 19691. *Cranial:* Total length, 24.4, 22.6, 22.6; basal length, 19.9, 17.7, 17.9; length of nasals, 9.6, 8.15, 8.55; zygomatic width, 13.05, 11.75, 11.75, width of braincase, 11.4, 10.3, 10.85; mastoid width, 9.55, 9.1, 9.25; interorbital width, 4.75, 4.25, 4.35; length maxillary tooth row, 3.1, 3.0, 3.0; length mandibular tooth row, 3.5, 3.15, 3.1; anterior width across molars, 5.0, 4.55, 4.5; posterior width across molars, 4.8, 4.05, 4.15; ratio of total length of braincase to its width, 46.5, 45.5, 48; ratio of width of braincase to interorbital

width, 41.5, 41, 40; ratio of anterior to posterior width across molars, 96, 89, 92.5. *External:* hindfoot, 23.15, 23.1, 22.9.

Specimens examined.—**Peru**: Rio Moyobamba, 1 (F. M. N. H.); Poco Tambo, 2 (F. M. N. H.); Inca Mines, 18 (A. M. N. H.), 2 (F. M. N. H.); Rio Cayumba, 2 (F. M. N. H.), 1 (M. C. Z.); Pomara, 1 (A. M. N. H.); Utucuyacu, Prov. Junin, 1 (A. M. N. H.); Pozuzo, 1 (F. M. N. H.).

NEAOCOMYS SPINOSUS CARCELENI Hershkovitz

Neacomys spinosus carceleni Hershkovitz, Occas. Papers Mus. Zool., Univ. of Michigan, no. 419, p. 1, June 27, 1940. Llunchi Id., Rio Napo, Napo-Pastaza Prov., Ecuador; latitude and longitude approximately 0°37′ S., 76° 46′ W.

This name recently has been given to the large *Neacomys* of eastern Ecuador in an attempt to distinguish it from the large forms of Peru and of Colombia; for the latter the name *tenuipes* had been retained. Actually *tenuipes* must be applied to the small species and, as it appears from the long series of specimens now available that the Colombian and Ecuadorian members of the large species cannot be separated, the name *carceleni* must be used for both of them.

The original description of this sub-species is good. Study of the long series of specimens from Curaray in the region of the type locality and comparison of these with the Inca Mines series emphasizes the average rather than absolute characters on which the race is based. The range of individual variation in color in the Curaray animals is even greater than in the Inca Mines series. In general the tendency is for the bright color of the back and sides in the former to have more red and less yellow. The back is "cinnamon-rufous" rather than "tawny" and shades into "apricot buff" on the lateral line. In a few specimens there is even a pale wash of "apricot buff" across the belly. This is in sharp contrast to the specimens from Inca Mines. A few specimens from Curaray are slightly more ochraceous than the one just described. As in the type series, most individuals have the ventral surface white, and of these only a few have the bases of the hairs slightly tinged with pale gray. All specimens that have a pinkish wash on the belly have the bases of the hairs gray but the tone is paler than in the Inca Mines series. Variation in foot color is about as described for *spinosus*; the hind foot averages longer in *carceleni*. Length of tail in the Curaray series is variable, partly owing to the preservation of the skins.

Cranially, the differences between the two races are almost entirely in average size. In the Curaray series the tooth row is longer and the supra-orbital ledges are more strongly developed and extend in a fine bead farther posteriorly on the parietals. The difference in divergence of the tooth rows in the two forms is slight and this character, as expressed in terms of the ratio of the anterior to the posterior width across the upper cheek teeth, is extremely variable.

Neacomys s. carceleni is further said to resemble the so-called *N. s. tenuipes* of Colombia more closely than it does *spinosus*. The series of so-called *tenuipes* from Paime, Colombia, which presumably were used for comparison in the original description of *carceleni*, includes one specimen of the small species to which this name must be applied. The three others appear indistinguish-

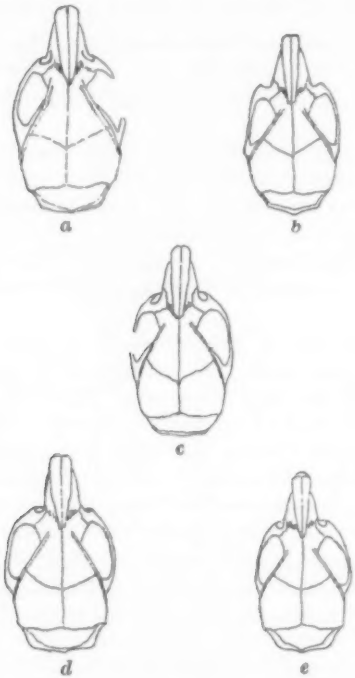

FIG. 2. Dorsal aspect of: a, *Neacomys spinosus carceleni*, A. M. N. H. 71526, from Curaray, Ecuador; b, *Neacomys tenuipes*, A. M. N. H. 71539, from Curaray, Ecuador; c, *N. s. spinosus*, A. M. N. H. 16528, from Inca Mines, Peru; d, *N. s. spinosus*, F. M. N. H. 19360, from Moyobamba, Peru; e, *N. s. spinosus*, F. M. N. H. 19690, from Poco Tambo, Peru.

able from the Ecuadorian animals. Two of them are no paler than the pale extreme of the type series, the third is no brighter than the most rufous of those from Curaray. Length of palatal foramina was also mentioned as a character by which the two races could be separated, when the one specimen of true *tenuipes* is set aside, but such a difference, although it exists, is not sufficient in my opinion to form the basis of a subspecific distinction.

Additional specimens examined include a number from the Oriente region in Ecuador, from the Napo drainage, and from the Pastaza and Marañon, all of which are well within the range of variation shown by the Curaray animals. From Colombia, in addition to the Paime specimens and another from the region of Bogota, there is a small series from La Morelia on the Rio Bodoquera (the name is erroneously spelled Murelia, see Frank M. Chapman's "The Distribution of Bird-Life in Colombia", Bull. Am. Mus. Nat. Hist., vol. 36, p. 648, 1917, for correction). This latter series includes one individual with the ventral surface darker than in any other specimen observed and it lacks the patch of white on the chin; the others are normal.

Measurements.—Measurements of the series from Curaray, Ecuador, are given in the following order: extremes and average for the males, followed by the same for the females. *Cranial:* Total length, 23.5–25.3 (24.4), 23.7–25.65 (24.56); basal length, 19.2–20.7 (19.86), 19.15–20.5 (19.77); length of nasals, 8.6–10.0 (9.28), 8.7–10.4 (9.47); zygomatic width, 12.1–12.9 (12.69), 12.05–13.75 (12.79); width of braincase, 10.9–11.7 (11.28), 10.6–12.0 (11.09); mastoid width, 9.25–10.0 (9.64), 9.4–9.9 (9.56); interorbital width, 4.6–4.85 (4.69), 4.35–5.0 (4.66); length of maxillary tooth row, 3.15–3.5 (3.37), 3.1–3.65 (3.41); length of mandibular tooth row, 3.4–3.95 (3.65), 3.4–3.9 (3.63); anterior width across molars, 4.75–5.1 (4.88), 4.5–5.15 (4.85); posterior width across molars, 4.35–4.75 (4.49), 4.1–4.65 (4.49); ratio of total length to width of braincase, 45–47.5 (46.3), 45–47 (46.1); ratio of width of braincase to interorbital width, 39.4–44 (41.9), 39.2–42.5 (41.1); ratio of anterior to posterior width across molars, 86.5–97 (90.9), 89.5–100.1 (92.5). *External:* Hindfoot, 22.8–24.85 (23.88), 23.0–24.5 (23.7).

Specimens examined.—Skin and skull unless otherwise stated: **Ecuador**: Boca Rio Curaray, 23 (A. M. N. H.); Llunchi Id., Rio Napo, 6 (U. of Mich. M. Z.); San Francisco, Rio Napo, 3 (U. of Mich. M. Z.); near Rio Napo, 3 (M. C. Z.); Rio Jatun Yacu, 2 (P. M.); near Archidona, 5 (M. C. Z.); Puyo, 2 skins (P. M.); Rio Capihuara, 3 (F. M. N. H.); Montalvo, Rio Bobonazo, 2 (F. M. N. H.); Canelos, 1 (A. M. N. H.); Mera, 3 (A. M. N. H.); Zamora, 3 (A. M. N. H.); San José, 1 and 1 skin only (A. M. N. H.). **Colombia**: Paime, 3 (A. M. N. H.); La Morelia, Rio Bodoquera, 1 and 3 skins only (A. M. N. H.); Mambita, Bogotá, 1 skin only (A. M. N. H.); Bogotá region, 1 (M. C. Z.).

NEACOMYS TENUIPES Thomas

Neacomys spinosus tenuipes Thomas, Ann. Mag. Nat. Hist., (7) vol. 4, p. 153, 1900. Guaquimay near Bogotá, Colombia.

Neacomys pusillus J. A. Allen, Bull. Am. Mus. Nat. Hist., vol. 31, p. 81, 1912. San José, Cauca, Colombia.

The small Colombian *Neacomys* was first described by Thomas who proposed *tenuipes* for a specimen taken at Bogotá. He also referred to it specimens "from 'Quebrada negra' and 'Magdalena Valley'." The race, he says, is similar to *Neacomys spinosus typicus* with "the general tone rather less vivid, the back darker, and the hairs shading off into fulvous rather than rufous. Belly-hairs pure white or dull white, not slate-based, though this latter characteristic proves to vary in *N. s. typicus*." I have at hand from the

Magdalena Valley in the Bogotá region six skins of which three from Quindio, El Roble, have the belly hairs washed with "ochraceous-buff" and the bases gray; the other three, one from Bagado and two from Paime, have the hairs whitish to the bases. In color of the back and sides these specimens resemble the series of *spinosus* much more closely than they do *carceleni*, except for one specimen from Paime that is slightly more rufous on the rump than is any specimen of *spinosus* I have seen. In none of them can I find any trace of dark marking on the hind foot; this character, as already seen, is variable and until longer series of *tenuipes* are examined too much importance should not be attached to it. The material at hand shows the short slender hind feet, mentioned by Thomas (*loc. cit.*), to be the most conspicous external difference. In addition the hind foot has the outer heel pad so reduced that it never appears as more than a slightly enlarged granule scarcely distinguishable from the surrounding granular area and, in two of the specimens from El Roble, the pad appears to be entirely lacking.

The cranial characters of *tenuipes* are worth noting as the original description of this form is of a skin only. Unfortunately, of the five specimens at hand from the Bogota region only one from Paime has a skull. This may be distinguished from that of *spinosus* principally by its much smaller size and shorter tooth row. The supraorbital ridges are pronounced as in *carceleni*, and in comparison with *spinosus* the Paime individual has the interorbital width slightly greater in proportion to the width of the braincase. Neither of these differences is striking and the skull in general is a miniature of that of the large species.

A second name, *pusillus*, was proposed for the small *Neacomys* by J. A. Allen. The description is based on a single specimen from San José, Cauca District, Colombia, a locality in the southwestern corner of the country not far from Barbacoas, "altitude, 200 feet, in the humid coast region." The description contains no reference to *tenuipes*, but the specimen is compared with *spinosus* and mention is made of the "lighter" hind feet in the former as well as of a striking difference in size. Comparison of the type of *pusillus* with specimens of *tenuipes* from the Bogotá region shows no significant differences. In color they are similiar; the type of *pusillus* has the belly hairs faintly gray-based, the hind foot of exactly the average length for the Bogotá series, and the characteristically vestigial outer heel pad is barely distinguishable. Comparison of the skull of *pusillus* with that of the Paime specimen shows them to be alike in size and length of tooth rows; the proportionally wide interorbital region and the heavier supraorbital ledges mentioned above for the Paime animal are slightly more pronounced in the type of *pusillus*. Additional specimens of this small species have been taken in eastern Ecuador. There are two from Curaray, together with the long series of *carceleni*, and with the shorter series of this same species taken near Archidona there is

another example of *tenuipes*. All three specimens have skulls which match closely the above description. Externally there are of course individual variations in color. The last-mentioned specimen is dark, owing to the fact that the bright-tipped hairs are largely concealed by the spines over most of the lower dorsal region. None of them has dark markings on the feet.

Measurements.—Measurements are given in the following order: Curaray, Ecuador, male, A. M. N. H. 71540; female, A. M. N. H. 71539; type of *Neacomys pusillus*, A. M. N. H. 31695. *Cranial*: Total length, 22.3, 22.4, 21.5; basal length, 17.5, 18.0, 16.8; length of nasals, 8.9, 8.8, 9.1; zygomatic width; ——, 11.0, 11.0; width of braincase, ——, 10.6, 10.3; mastoid width, 8.9, 9.1, 8.8; interorbital width, 4.6, 4.6, 4.55; length of maxillary tooth row 2.7, 2.8, 2.8; length of mandibular tooth row, 2.85, 2.95, 3.0; anterior width across molars, 4.2, 4.3, 4.05; posterior width across molars, 3.9, 4.3, 3.95; ratio of total length to width of braincase, ——, 47.5, 47; ratio of width of braincase to interorbital width, ——, 43.5, 44.2; ratio of anterior to posterior width across molars, 93, 100, 97.5. *External:* Hindfoot, 20.6, 20.8, 20.4.

Specimens examined.—Skin and skull unless otherwise stated: **Ecuador**: near Archidona, 1 (M. C. Z.); Boca Rio Curaray, 2 (A. M. N. H.); Mera, 1 (A. M. N. H.). **Colombia**: Paime, 1 and 1 skin only (A. M. N. H.); Quindio, El Roble, 3 skins only (A. M. N. H.); Bagado, 1 skin only (A. M. N. H.); Cauca, San José, 1 (type of *pusillus*, A. M. N. H.).

CONCLUSIONS

The genus *Neacomys* in northwestern South America is represented by two species, a smaller, *N. tenuipes*, found in Ecuador and Colombia, and a larger of which two races are recognizable, *N. s. spinosus* in Peru, and *N. s. carceleni* from eastern Ecuador and from Colombia. Long series of both races show them to be extremely variable, particularly as regards external characters, and separable, principally, on the basis of average differences. *N. tenuipes* is not geographically isolated but occurs, to some extent anyway, in the same regions as *N. s. carceleni*.

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NOTES ON THE TEETH OF THE SEA OTTER

By Edna M. Fisher

During the study of the bones of the sea otter, *Enhydra lutris lutris* and *Enhydra lutris nereis*, several interesting features have been noted, some of which are included in this paper. The smooth rounded surfaces of all the teeth and the marked flatness or concavity of the molars are features that characterize the bunodont teeth of the sea otter. The teeth are well adapted to crushing and grinding but in no way for cutting or shearing. This modification is interesting as the sea otter feeds entirely on flesh.

There are available for study mandibles and maxillae, complete and fragments, of all ages of the sea otter and quantities of loose teeth that have dropped out. None of the teeth is firmly anchored in the bone hence they drop out readily when cleaned or after years in a shellmound. When possible, the original teeth have been glued back into their proper places.

From the material available the following table has been prepared to show tooth succession. Since there are no pup skulls or mandibles present that have any of the incisors in place it is necessary for the present to accept the counts made by some of the earlier observers. The mandibles of the youngest pups available show two large deep incisor alveoli that are as one at the upper margin. Three small teeth might be crowded sideways into this space, but it appears that milk incisor$_3$ is located still more lateral to these two in an aveolus of its own and lateral to the developing permanent canine tooth. (fig. 1) Since this is the case it would be milk incisor$_3$ that is crowded completely out, never being replaced by a permanent incisor. Most authors have assumed that it is incisor$_1$ that is lost from the permanent dentition. The number and arrangement of the alveoli do not bear out this assumption. The youngest mandible available is one in which milk premolar$_2$ has not appeared, being still partly covered by a thin layer of bone; also, in which the permanent canine, barely formed, shows its relation to the alveoli of the milk dentition through a break in the bone. This, too, seems to give added evidence that it is incisor$_3$ that never appears in the permanent set.

There is a remarkable crowding of the teeth in the anterior part of the mouth so that several alveoli are united at their upper margins. This condition is true for the incisors and canine and premolar$_2$ of the permanent teeth and of the milk incisors $_1$ and $_2$. Perhaps premolar $_2$ will be crowded out sometime and further reduce the molar series.

The pattern of the premolar milk teeth is quite different from any of the permanent set in that the crowns are higher in proportion, the cones are noticeably higher and sharper, and there appears to be a greater number of cones present (fig. 2 a, b). There is sufficient space so that the milk teeth are not crowded on the mandible, also they are relatively small when compared with the large, broad permanent teeth.

The permanent teeth are unique in that all cones and edges are smooth and rounded, and the molars show a tendency to be concave. The crown of the

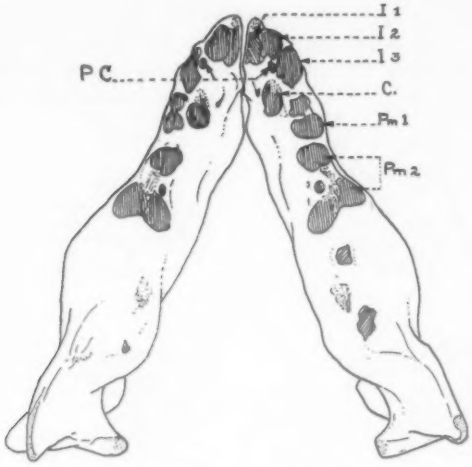


FIG. 1. Mandible of pup showing arrangement of milk teeth. $I_{1, 2, 3}$ milk incisors; C, milk canine; $Pm_{1, 2, 3}$ milk premolars; PC, region of permanent canine.

TABLE I.—*Development of dentition in sea otter*

Pup	Stage 1	Upper	MI 1, 2, 3	MC 1	MPm 1, MPm 2		$-6\}\frac{12}{12}=24$	
		Lower	MI 1, 2, 3	MC 1	MPm 1, MPm 2		$-6\}$	
	Stage 2	Upper	I 1, 2, 3	MC 1	MPm 1, MPm 2		$-6\}\frac{12}{10}=22$	
		Lower	I 1, 2, –	MC 1	MPm 1, MPm 2		$-5\}$	
Cub	Stage 1	Upper	I 1, 2, 3	C 1	Pm 2, MPm 1, MPm 2		$-7\}\frac{14}{12}=26$	
		Lower	I 1, 2, –	C 1	Pm 2, MPm 1, MPm 2		$-6\}$	
	Stage 2	Upper	I 1, 2, 3	C 1	Pm 2, MPm 1, MPm 2	M 1,	$-8\}\frac{16}{16}=32$	
		Lower	I 1, 2, –	C 1	Pm 2, MPm 1, MPm 2	M 1, 2	$-8\}$	
Subadult		Upper	I 1, 2, 3	C 1	Pm 2, Pm 3, MPm 2	M 1,	$-8\}\frac{16}{16}=32$	
		Lower	I 1, 2, –	C 1	Pm 2, Pm 3, MPm 2	M 1, 2	$-8\}$	
Adult		Upper	I 1, 2, 3	C 1	Pm 2, Pm 3, Pm 4	M 1,	$-8\}\frac{16}{16}=32$	
		Lower	I 1, 2, –	C 1	Pm 2, Pm 3, Pm 4	M 1, 2	$-8\}$	

tooth is low and it is doubtful if the tooth surface extends much above the gum level. The permanent teeth are covered with a layer of enamel about 1 mm in thickness. Just under the enamel is a thicker layer of dentine that is about

2 mm in thickness. The center of the tooth is one large extensive pulp cavity that is continuous with the rather small root canals (fig. 2, c., d.).

In older individuals, as the surface wears away more dentine is deposited within the pulp cavity to compensate for the wear. As the deposit increases this secondary dentine almost obliterates the original pulp cavity.

The teeth of the sea otter are adapted for grasping or tearing and for crushing. As far as is known the food of the southern sea otter consists mainly of

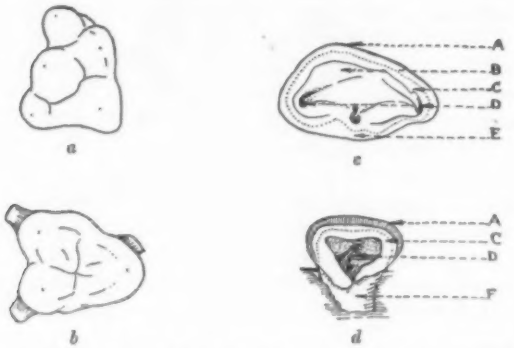
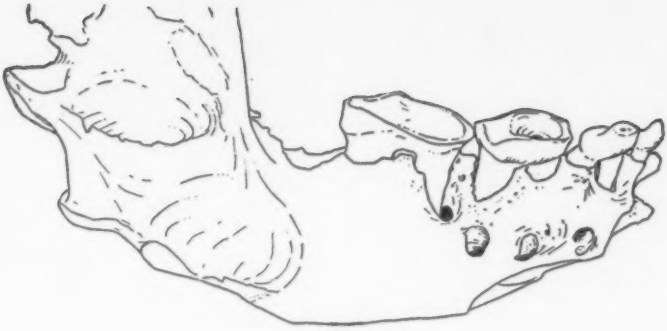


FIG. 2. a. lower right second milk premolar, b. upper right second milk premolar (Anterior tooth margin at the top), c. surface view of pulp cavity, crown removed, d. side view of molar tooth in section (A. layer of enamel, B. pulp cavity, C. inner layer of dentine, D. root canals, E. outer layer of dentine, F. root partly exposed).

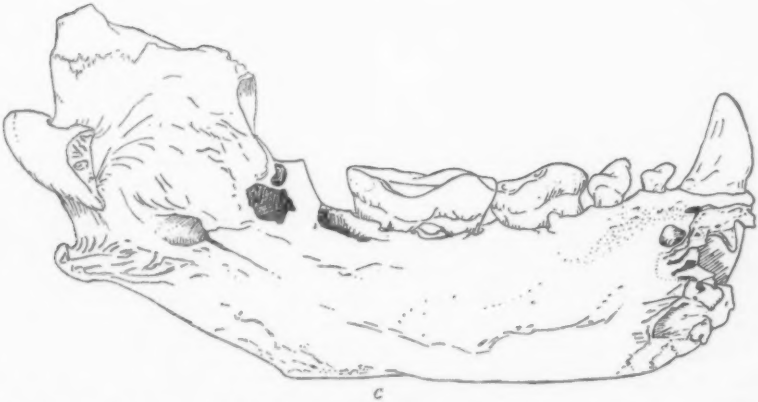
FIG. 3. a. normal upper right fourth premolar. ×2. b. normal upper right first molar. ×2. c. f. fourth premolar with cavities. ×2 d. e. first molar with cavities. ×2.

the abalone, sea urchins, sea cucumber and crabs (Fisher, 1939; 1940; Bolin, 1938). Abalone furnishes the bulk of the food and is of such a nature that very little chewing would be required. Judging from the stomach contents of one otter examined recently the animal swallowed large chunks of meat as fast as they could be torn out. Of the sea urchins few of the exoskeletal parts are swallowed, those that are consist mainly of parts of Aristtotle's lanterns. The crabs were well crushed and reduced to small pieces. In the one stomach examined no parts of mussels or clams have been identi-



a

b



c

FIG. 4. a. right mandible, areas of infection around roots of molar$_1$, premolars$_{3,4}$ on outer surface.

b. left mandible, area of infection at root of premolar$_4$ and molar$_1$. Molar$_1$ lost due to the severity of the infection.

c. left mandible, large area of infection posterior to molar$_2$, also at mental symphysis.

fied to date. Olaus J. Murie (1940), in studying the scat contents of the northern sea otter, found not only Aristotle's lanterns but also spines and plates of the tests. He also shows in the same article that this northern form depended on the sea urchin for the bulk of its food and to a far lesser extent on the rock oyster. Barabash-Nikifrov (1935), after examining about 500 sea otter scats from the Commander Islands, states that 59 per cent of the food was sea urchin and a little more than 23 per cent mollusks of various kinds, but mainly bivalves. There is some possibility that this difference in food habits may explain the apparently greater number and larger size of the cavities appearing in the teeth of the northern form as compared with those in the teeth of the southern form.

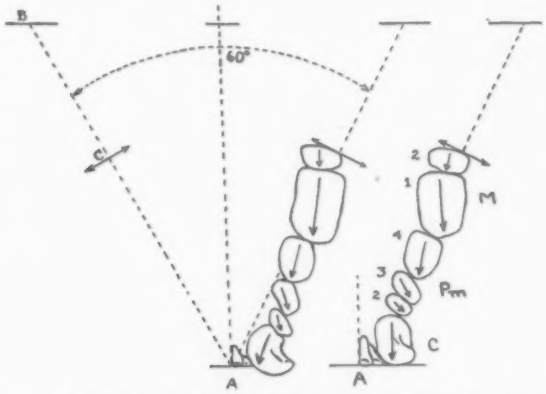


FIG. 5. Diagram to show spacing of the teeth and the angle between the rami, A. anterior at the mental symphysis, B. condyloid process, C. length of the tooth row.

Cavities noted varied in size from minute holes to large ones, from shallow depressions to deep ones. Cavities occur on both the upper and lower teeth, primarily on the molars and fourth premolars less often on the teeth anterior to these. The holes may be formed on the cones, in the various grooves or even on the rounded sides of the teeth. There may be only one cavity present or a great number of them as illustrated in the diagrams (fig. 3).

Besides cavities in the teeth, the sea otters suffered from abcesses of varying intensity that affected one or more teeth. Some of the abcesses were the cause of the loss of teeth. It is impossible to determine the causes of the infections attacking the bones and teeth, but it seems probable that the epithelium of the mouth might easily have been broken in the process of biting open the tests of the sea urchins upon which they feed (fig. 4).

Another point of interest is the variation that occurs in the angle formed by the two mandibles. The mental symphysis is rarely if ever ankylosed even

in the oldest individuals so it has been impossible to measure this angle in any great number of individuals. The upper tooth rows also form an angle that varies but due to the fragmentary condition of most skull remains little can be determined from their measurements. So far the general statement can be made that in the younger animals the angle is greater and the mandibular length shorter, and with the increase in age the angle between the mandibles decreases and the length increases.

In measuring tooth size, the length of the molar series, and the above angle for many individuals another feature of interest was noted. The spacing of the teeth in the mandible was noted to vary in such a way as to suggest that some evolutionary change might be taking place. It seemed to suggest that the teeth were becoming too large for the mandible or the mandible was becoming too short to hold the teeth or, perhaps, it was a combination of the two. At any rate in some of the mandibles there is room enough for the teeth to be so placed that the long axis of the crown is almost parallel to the long axis of the mandible. In some it is most evident that there is not sufficient room and as a result the teeth are crowded in at various angles to the main axis of the bone. The face bones of the sea otter are comparatively short now and perhaps this crowding of the teeth indicates a continued tendency to shorten the face to a still greater extent (fig. 5).

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DEVELOPMENT OF CHARACTERS IN HORSE TEETH AND THE DENTAL NOMENCLATURE

By R. A. Stirton

The purpose of this report is to trace the development and evolution of certain characters in the cheek teeth of the horse to afford a more satisfactory basis for determining their value in phyletic interpretations.

The primitive pattern and basic plan from which all later horse teeth were formed is that of *Eohippus* from the Lower Eocene (Figs. 1–2). In the upper

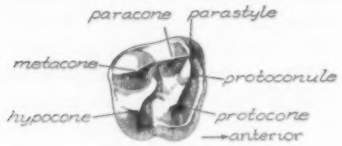

Fig. 1

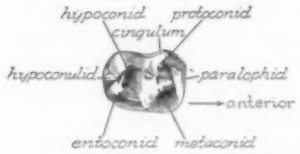

Fig. 2

Figs. 1. *Eohippus* [cf. *resartus*], "Wasatch," Lower Eocene. M^2—partly restored and drawn in reverse, times 1½, Mus. no. 27535.

Fig. 2. *Eohippus* [cf. *resartus*], "Wasatch," Lower Eocene, M_2, times 1½, Mus. no. 27534.

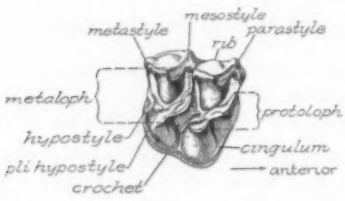

Fig. 3

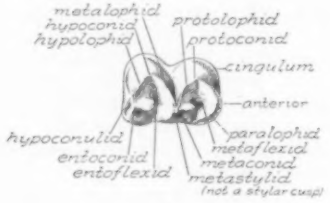

Fig. 4

Fig. 3. *Parahippus* cf. *nebrascensis*, Flint Hill, Lower Miocene, P_4, times ¾, Mus. no. 35894.

Fig. 4. *Parahippus* cf. *nebrascensis*, Flint Hill, Lower Miocene, P^4 drawn in reverse, times ¾, Mus. no. 35763.

teeth there is one external crest that is connected with two somewhat oblique inner crests. These have been named the ectoloph, protoloph and metaloph. The protoloph and the metaloph are continuous from the anterior base of the paracone and metacone respectively. But in the Oligocene horses the transverse lophs are not attached to the ectoloph and at this time the metaloph has shifted slightly forward to a position opposite the mesostyle. Even in *Eohippus* most of the cusps, so prominent in later horses, are quite distinct. Those present in *Eohippus* and frequently referred to in the dental terminology of later horses are paracone, metacone, protocone, hypocone, protoconule,

metaconule and parastyle, in the upper teeth, and metaconid, entoconid, protoconid, hypoconid, and hypoconulid, in the lower teeth.

There are so many distinctive characters in horse teeth that a detailed nomenclature is necessary. Such a nomenclature was introduced by Osborn (1907) and with some minor alterations and additions is now well established in paleontologic literature. In this report certain changes are suggested to clarify the application of names and four new names are suggested. Parastylid is applied to the stylar development on the antero-labial corner of lower

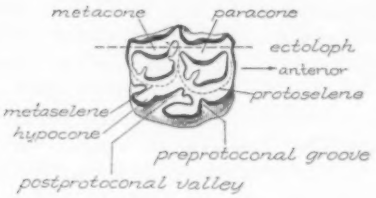

FIG. 5

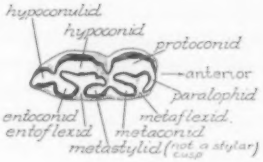

FIG. 6

FIG. 5. *Pliohippus* (*Astrohippus*) *ansae*, Hemphill, Middle Pliocene, upper molar drawn in reverse, times ¾, Mus. no. 35541.

FIG. 6. *Pliohippus* (*Astrohippus*) *ansae*, Hemphill, Middle Pliocene, lower molar, times ¾, Mus. no. 35542.

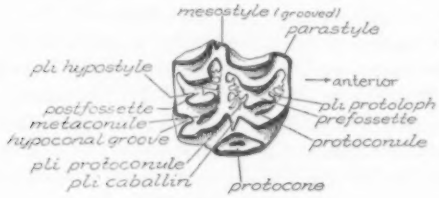

FIG. 7

FIG. 8

FIG. 7. *Neohipparion eurystyle*, Hemphill, Middle Pliocene, upper premolar, times ¾, Mus. no. 35892.

FIG. 8. *Neohipparion eurystyle*, Hemphill, Middle Pliocene, lower premolar, times ¾, Mus. no. 35893.

teeth and not to the lophid which extends from the protoconid to the antero-lingual corner—this crest is called **paralophid** (new name). Ectostylid is replaced with **pli caballiinid** (new name) and entostylid is eliminated. Protostylid, not to be confused with the pli caballinid, is applied to the labial-median stylar cusp on lower teeth. **Metaflexid** and **entoflexid** are new names for the two prominent lingual inflections.

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UPPER TEETH

Protocone.—The presence of the protocone and the protoconule as distinct cusps on the protoloph is apparent even in *Eohippus*. A niche occurs on the crest between these two cusps; it becomes more prominent in Middle and Upper Eocene horses. In *Mesohippus* and *Miohippus* there seems to be no greater separation or distinction in the cusps though the teeth have become larger and the protoloph is higher. This same condition prevails throughout the succession of hypohippine horses.

Many individual teeth of *Parahippus*, particularly in the advanced species, display a greater constriction and deepening of the niche between the protocone and protoconule but in others the earlier connection is retained. In the Middle Miocene species of *Merychippus* there is much variation in the tendency toward isolation of the protocone. Most of the specimens are broadly connected and where isolation does occur it is in the upper one-fifth of the crown. Upper Miocene merychippines, especially the advanced species, display definite trends toward *Pliohippus* (in *Merychippus perditus*) or *Hipparion* (in *Merychippus insignis*), though at this time the isolation of the protocone is not complete.

Hipparion, *Neohipparion*, and *Nannippus* include the American genera with isolated protocones in the upper cheek-teeth. In all but two of the described species the isolation extends to the base of the tooth. These are *Nannippus retrusus* (Cope) and *Nannippus gratus* (Leidy). One undescribed species of *Hipparion* shows the same character. Of course an occasional individual tooth of the other species sometimes displays a reversion to the primitive type. In the *Nannippus* species mentioned here the protocone is connected in the lower one-third of the tooth. Abel (1926, 1928) mentions the same character in *Hipparion matthewi* (possibly a synonym of *Hipparion minus* Pavlow) from Samos Island in the Aegean Sea; but a maxillary of this small *Hipparion* (U. C. Mus. Pal. No. 21743) from Samos and here in our collection shows every indication that the protocones remain isolated to the base of the teeth. The shapes of isolated protocones range from round in Old World hipparions to extremely elongate in advanced American neohipparions, and there is much variation in the outline in any given species. In *Neohipparion* it is usually grooved lingually. This is also true in *Equus* and advanced species in the subgenus *Astrohippus*.

The isolated protocone is obviously a weaker structure than the connected protocone, but development of cement in the postprotoconal valley and preprotoconal groove seems to have supplied sufficient additional strength to support this isolated structure. In fact I have seen only one isolated protocone that was broken off the main body of the tooth and that was in an unerupted tooth on which cement had not yet been deposited.

The horses that possess a connected protocone simply retain a pattern that is nearer the primitive condition. As stated above the two main groups of

hypsodont horses (hipparions and protohippines) first show some differentiation in the late Lower and early Middle Miocene species of *Merychippus*. This distinction became more pronounced in the succeeding stages. Frequently *Merychippus* teeth are thought to have isolated protocones when attrition has barely exposed the dentine below the higher points on the tooth. This is particularly true in *M. primus* where a little more wear discloses a well united protocone. In early stages of wear the isthmus between the two cusps is always more restricted than in heavily worn teeth. Interestingly enough, teeth referable to the later protohippine lines show, relative to height of crown, that this narrower condition extends farther toward the base of the tooth. This is well illustrated in *Equus*. Thus the stages of wear in a hypsodont horse tooth tend to recapitulate the history of the group to which it belongs.

Even in the horses with connected protocones there seems to be an occasional tendency toward isolation. This occurs in the upper part of the crown and is displayed in *Pliohippus supremus* (Leidy) and *Equus fraternus* Leidy. And Abel's (1928) arguments to the contrary notwithstanding there is no evidence for the protocone becoming again connected with the main body of the tooth once it has become isolated.

The position of the protocone in relation to the ectoloph has recently attracted some attention. The inference is that it lies opposite the mesostyle in Pliocene and later horses but in *Merychippus* and earlier forms its position is anterior to the mesostyle. A check on the Equidae in our Miocene and later faunas reveals the normal position of the protocone to be opposite a point between the paracone and mesostyle. This is true in Recent horses as well as in those from the Miocene, although individuals from time to time show the protocone to be opposite the mesostyle. Therefore the inadequacy of this as a diagnostic character is apparent.

Pli caballin folds.—The pli caballin first appears in advanced species of *Parahippus* (*P. vellicans* (Hay)) as a labial division of the crochet, which sometimes occurs prior to a connection of the crochet with the protoloph. In these parahippines as well as in species like *Merychippus primus* the pli caballin is present or absent. Only in a low percentage of later species is this true. Frequently it does not appear in early stages of wear but shows up toward the base of the tooth. Many individual teeth in Upper Miocene *Merychippus* display a twofold division of the pli caballin and in some Lower Pliocene species of *Hipparion* there is a triple division. An extreme is seen in *Proboscidhipparion* from the Nihowan Upper Pliocene of China, which has four pli caballin folds. These extra pli caballines may appear as divisions of a fold already formed or as new extensions from the outer borders of the metaselenes or protoselenes. The number present in an individual cheek tooth series may vary from three in the premolars to one in the molars.

Fossettes.—The first complete enclosure of the fossettes occurs in the earliest species of *Merychippus*. Individual teeth, even in much later forms, show in-

complete closure. These most frequently show the prefossette opening into the postprotoconal valley, or the pre and postfossettes being united along the inner edge of the ectoloph. Sometimes the postfossettes open posteriorly through the hypoconal groove of M^3 and rarely does the prefossette of P^2 open anteriorly or directly anterior to the pli caballin.

Plications.—The first fossette plications, which are so clearly displayed in late Tertiary horse teeth, appear in *Parahippus* before the fossettes are formed. They arise as small ridges of enamel on either side of the metaloph. The additional folds so apparent in the hipparions arise as multiple divisions from the folds already formed or as new folds from edges of the fossettes. This is also true but to a lesser degree in *Pliohippus* and *Equus*. The pli protoloph and pli hypostyle are first to be seen in *M. primus* and related species. And even here the pli hypostyle seems to antedate the pli protoloph. The occurrence of plications on the metaloph in given species of *Archaeohippus* has led some writers to assume a generic relationship of these forms to *Parahippus*.

Other features that have attracted attention are the depth of the grooves and inflections anterior and posterior to the protocones. Many of the late Tertiary horses display numerous plications and deep inflections in the enamel patterns of the cheek-teeth. These more efficient triturating surfaces seem remarkably suitable for herbivorous animals in an area of increasing aridity. As a factor in increasing the enamel surface the postprotoconal valley extends deeply in most species of *Equus* and also occurs in some of the Chinese hipparions, *H. richthofeni* and *H. polyodus*, as well as in some teeth of *Pliohippus interpolatus* from Texas. This deepening is true but to a lesser degree of the preprotoconal groove, which restricts the connection of the protocone-protoselene to a narrow isthmus. It led Abel (1926, 1928) to conclude that this was a new connection for the photocone via the first pli caballin.

Hypostyle and *Pli hypostyle.*—The development of the hypostyle and pli hypostyle are important steps in the completion of the postfossette. Osborn (1907) defines the hypostyle as a development on the posterior cingulum near the hypocone in *Mesohippus* and *Anchitherium*. He says that the hypostyle "finally completes the border of the 'anterior fossette' or cement lake." He might have stated that the hypostyle together with the pli hypostyle and the posterior cingulum complete the formation of the postfossette. There is a faint elevation of the posterior cingulum in the position of the hypostyle in *Epihippus*. In *Mesohippus* there is an anterior extension from the hypostyle that forms the pli hypostyle, but in some species (*M. protentus* Douglass, *M. hypostylus* Osborn, *M. obliquidens* Osborn) the pli hypostyle seems to develop as a cusp independent of the cingulum. *Miohippus* shows the hypostyle-pli hypostyle to be an enlarged V-shaped structure. Then in *Anchitherium* and *Archaeohippus* the pli hypostyle curves posteriorly and joins with the posterior cingulum to form a small semicircular hypostylar loop with the point toward the metaconule. There is also a tendency toward a

connection of the inner edge of this loop with the metaloph. *Hypohippus* and *Megahippus* are much like the old world *Anchitherium* in the development of this area. They are, of course, much larger and appear to accentuate the characters, but an elevated connection of the hypostylar loop to the metaloph occurs only in the last two molars. *Anchitherium praestans* (Cope) is nearer *Miohippus gemmarosae* Osborn in that the tip of the pli hypostyle is recurved but not connected to the posterior cingulum. Thus they are intermediate between typical *Miohippus* and *Anchitherium*. Simpson (1932) describes the hypostyle in *A. clarencei* as being "triangular, circular, pitted, united by crest to hypocone." This is nearer the old world typical anchitherines.

The genus *Parahippus* is quite variable. Some species develop the hypostylar loop and in others, *P. vellicans* (Hay), *P. leonensis* Sellards and *P. brevidens* (Marsh), the pli hypostyle extends into the area of the future postfossette (fig. 3). These species seem nearest the ancestry of *Merychippus* and the later hyposodont horses. In these horses the cingulum develops an elevated connection with the ectoloph and thus forms the posterior border of the postfossette. A hypostylar loop is seldom formed.

Hypoconal groove.—A closing of the hypoconal groove in the formation of a tiny fossette occurs rarely in late Tertiary Equidae but in two species *Nannippus retrusus* and *N. gratus* it is so persistent that it is a useful character in recognizing these species. It is formed by a fusion of the hypocone and hypostyle along the posterior edge of the tooth. In many individuals particularly in *N. retrusus* the groove is open in the upper third of the tooth's crown. In most species of hypsodont horses the hypoconal groove is open to the base of the tooth.

Styles and ribs.—Granger (1908), in his revision of the Eocene horses, included in his diagnosis of *Eohippus* the absence of a mesostyle. The parastyle and external ribs are well developed. The mesostyle first appears in *Orohippus*, and in *Epihippus* the parastyles and mesostyles are more prominent than the ribs. This ribbing on the labial side of the ectoloph is present in all Oligocene and Lower Miocene horses. It persists in *Anchitherium* and *Archaeohippus* up to the close of the Miocene. Although there is some indication of it in the earliest species of *Hypohippus*, this area becomes conspicuously grooved in later species of the genus. The ribs are rather clearly indicated in *Parahippus*, less so in the species of *Merychippus* and present or absent in the Pliocene horses.

The styles are characteristic in some genera and species. Of the three the metastyle is least developed; it is absent in the Eocene horses and absent or only faintly indicated in the Oligocene forms. The parastyle is the largest. Most species of *Merychippus* show a wide base on the parastyle and mesostyle that becomes conspicuously narrower toward the occlusal surface. In Pliocene and later forms the width of these styles is more persistent throughout their length. Many Pliocene and Pleistocene species display a flattening and

even a grooving of the styles. This is clearly shown in some species *Neohipparion* (Fig. 7) and *Equus*.

Cingulum.—*Eohippus*, *Orohippus*, and *Epihippus* show well developed cinguli around the molars but in some teeth they are discontinuous on the lingual sides of the protocones and hypocones. The formation of the external styles from the labial cingulum is clearly displayed in the Eocene horses, and as stated previously, the hypostyle arose from the posterior cingulum.

The history in the premolar development is somewhat different. Granger's (1908 p. 261, fig. 4) illustrations indicate that the protocone of P^3 arose from the anterior cingulum, although he does not say so in his text. Wortman (1896 p.105, fig. 14) shows the protocone on P^3 of *Eohippus venticolus* (Cope) as having arisen, in all probability, from the anterior cingulum. But if his *Orohippus* (fig. 18) is a descendant of *E. venticolus* the cusp in question must have migrated into the main body of the tooth and then a secondary cingulum formed along the antero-internal edge of the tooth. If the sequence of the species in Granger's figure (p. 261, fig. 4) is a true phyletic descent he has furnished good evidence for the migration of a cingular cusp with the formation of a secondary cingulum on P^2 in Eocene horses.

The cingulum is discontinuous along the lingual edge of the teeth in Oligocene horses, though there is usually a remnant between the protocone and hypocone, particularly in *Mesohippus*. This is not uncommon in later anchitherine and hypohippine horses. *Megahippus* is unique in possessing a continuous and well developed cingulum along the inner edge of the premolar. The anterior cingulum disappears along the antero-external edge where it is oppressed against the tooth in front. The posterior cingulum forms the posterior edge of the postfossette in the formation of a connection between the parastyle and hypostyle.

LOWER TEETH

Metaconid-metastylid.—One of the most useful characters in the identification of lower teeth is the separation of the metaconids and metastylids together with the shape and extent of the intervening valleys. In *Eohippus* there is a faint indication of twinning or division of the two cusps apparently from one. This division is a little advanced in *Orohippus* and *Epihippus*. In *Mesohippus* and later horses the metaconid is innervated by a nerve arising from the anterior root, whereas the metastylid is connected with the posterior root. This is shown by the dentinal depositional pattern (fig. 9.), and is accompanied by a widening, flattening and postero-basal expansion of the metaconid-metastylid pillar. These external characters are displayed in Oligocene and Lower Miocene horses and in all of the hypohippines. After *Mesohippus* there is not much change in this respect until *Parahippus* appears in the Lower Miocene. Even in such advanced hypohippines as *Megahippus* there is no greater external distinction in these cusps than in *Orohippus*. But

in *Parahippus* and with the gradual inception of plains conditions the cusps became more widely separated and the intervening valley became deeper and extended farther down the tooth. *Merychippus* through its numerous species displays interesting diversification and progression in this character. There is a tendency toward a wider division of the metaconid and metastylid in those species that are progressing toward an isolated protocone in the upper teeth. In *Hipparion* and related genera the separation of these cusps is complete and this extends to the base of the teeth.

With the extension of the metastylid posteriorly and the entoconid anteriorly the space between these cusps becomes a narrow inflection. In the protohippine groups the metaconids and metastylids do not separate so widely and either merge or show a strong tendency to do so toward the base of the tooth. Here, too, we find that the space between the metastylid and ento-

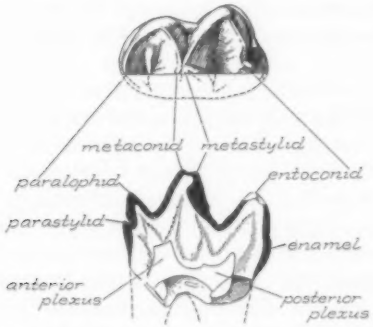

FIG. 9. *Mesohippus bairdi*, White River, Oligocene, lower molar, occlusal and cross-sectional views, times 2, Mus. no. 35891.

conid is much greater. Finally, however, in advanced species of the subgenus *Astrohippus* a development parallel to that already developed in the hipparions is seen. This is accompanied by an enlargement and elongation of the protocone in the upper teeth. The metaconids and metastylids are also widely separated in *Equus*.

The term metastylid was first used by Osborn (1907, p. 70; p. 174, fig. 160, p. 177, fig. 164) to quote—"Similarly, in the lower molars, we find in several lines of Ungulates, but again most conspicuously in the Equidae, that the metaconid and entoconid are reinforced by little cusps which grow up behind them (a,a and b,b, Rütimeyer); these may be termed respectively the *metastylid* and *entostylid*,"—but it is a misnomer. The metastylid did not arise from the cingulum nor is it a peripheral cusp. The sequence of middle and late Tertiary horse teeth clearly indicate that it arose from the posterior half of

the metaconid and that it is innervated from the posterior and not the anterior nerve plexus (see fig. 9).

Paralophid.—Osborn (1907, pp. 83, 84) states, "In the lower molar the trigon loses the 'paraconid'. . . . The development of the talon necessitated the loss of the 'paraconid', for they both occupy the same space when the jaws are closed; the stages of this gain to the upper molar and loss to the lower molar are well shown in the species of *Euprotogonia*" [now *Tetraclaenodon*].

It is true that the paraconid as a cusp is lost in *Eohippus* if we deprive these oldest horses from a type possessing a tooth structure like the condylarth *Tetraclaenodon*. But Osborn refers to the lingual tip of this crest as the parastylid, apparently assuming that its prominence in later forms is due to a partial fusing with the anterior cingulum. Actually no cusp is again developed on the equid paralophid and the anterior end of the cingulum does not extend to the top of the crest. Therefore in this report the original crest is called the **paralophid** since it persists thorughout the history of the Equidae and obviously is the crest that connected the protoconid and paraconid in an ancestral type.

Parastylid.—The anterior cingulum extends only halfway across the front of the tooth in *Eohippus* but in *Epihippus* it reaches a point below the lingual tip of the paralophid. As the teeth become higher crowned in later horses this cingulum extends from the lower anterior labial corner diagonally up and across the front of the tooth. In the hypsodont horses, including *Merychippus* and its descendants, it arises vertically from the lower labial base of the tooth as a sharp narrow ridge that flattens out across the tooth lingually where it merges with the paralophid. Since it originates from the cingulum it is referred to as the parastylid. This differs from Osborn's (1907, p. 70; p. 174, fig. 160) designation. Not all cusps that arose from a cingulum are now called stylar cusps. In some groups of mammals the cusp called hypocone originated from a cingulum and in others it apparently arose from the main body of the tooth. In *Hipparion*, *Neohipparion*, *Nannippus*, and *Pliohippus* there is a tendency toward, or a definite, isolation of the tip of the parastylid. This occurs in early stages of wear and is of more frequent appearance in certain species. Indeed in some old world species it may be of specific distinction. Some teeth of *Nannippus* display numerous tendencies toward an isolation of this kind along the entire length of the parastylid ridge almost making a serrate appearance.

Van Hoepen (1932) observed the isolation of the parastylid in *Hipparion*, certain zebras and two extinct African horses and concluded that the zebras and two African horses had descended from *Hipparion*.

Hypoconulid.—In discussing the evolution of the ungulate molar Osborn (1907 p. 83) stated, "In the lower molar the trigon loses the 'paraconid' the talon loses the 'hypoconulid', the latter persisting only in the last molar as the 'third lobe'." Evidently he thought the hypoconulid was retained in *Hyra-*

cotherium leporinum Owen since he used that name for the posterior median cusp on a lower molar (p. 174, fig. 159 B). But in fig. 164 he labeled the posterior cusp on *Hipparion* and *Equus* as the entostylid. In 1918, however, Osborn labeled the posterior cusp on all equid lower molars and premolars as the hypoconulid.

Until the Paleocene predecessors of *Eohippus* are known it is not possible to determine the homology of the perissodactyl hypoconulid. It may be significant to note, however, that in *Eohippus* the hypoconulid occurs in a median position on the posterior cingulum slightly posterior to a line drawn between the entoconid and hypoconid, and that in *Epihippus* it has shifted to a position posterior to but slightly labial from the entoconid. This is the position seen in many insectivors, marsupials, creodonts and in some condylarths, and is usually considered a primitive arrangement of these cusps.

The position of the cusp in *Epihippus* is retained in *Mesohippus*, *Miohippus*, *Archaeohippus*, and *Anchitherium*. *Hypohippus osborni* Gidley shows the cusp in a similar position but in the more advanced *H. affinis* Leidy it is located a little more lingually, whereas in *Megahippus* it occurs directly behind the entoconid.

Teeth of *Parahippus* have a distinct lingual groove between the entoconid and hypoconulid that extends nearly to the base of the tooth. In all the later hyposodont horses the hypoconulid extends posteriorly in the upper part of the tooth's crown, so much so that unworn first and second molars are sometimes confused with M_3, which has a rather elongate hypoconulid. The first two molars may be readily identified by a flattening of the hypoconulid in the basal two-thirds of the tooth, whereas in M_3 it is usually more elongate at the base of the tooth. The characteristic shape in M_{1-2} is indirectly caused by the different time of their ossification. Thus when the upper third of M_1 is developing there is no tooth oppressed against it from behind therefore the hypoconulid may expand posteriorly until the next tooth, M_2, has developed to a stage where such oppression can take place and this results in a flattening of the hypoconulid.

Entoconid.—In *Parahippus* there is a slight extension of the entoconid that Osborn (1918 fig. 3) called the entostylid. This differs from his interpretation in which he referred to the posterior cingulum cusp as the entostylid; later (1918 fig. 3) he called it a hypoconulid. His last designation is followed here. This antero-median development of the entoconid is displayed to a limited extent, in the hypohippine and later anchitherine horses but only faintly indicated in *Miohippus*. It is quite conspicuous in the later hypsodont horses but only in early stages of wear. I therefore question the practicability of giving this part of the entoconid a distinct name. It is intimately connected with the entoconid and it does not form a separate cusp. Then too it disappears in an early stage of wear. Similar extensions may be seen on the protocones in the upper teeth. In any event it should not be called entostylid for

it has never had a connection with the cingulum nor did it arise from parts of the tooth that developed from the cingulum.

Metaflexid-Entoflexid.—There are two inflections in lower horse teeth that expand in the middle of the tooth. Thus equid lower teeth differ from those in the artiodactyls that show similar areas as fossettids. New names are here given to these structures in horse teeth. The **metaflexid** enters between the paralophid and the metaconid; it then expands posteriorly and occupies the space bordered by the paralophid, protolophid, metalophid, and the metaconid. It is roughly L-shaped. The paralophid is so low in *Eohippus* that only a shallow groove occurs in the area of the future metaflexid. The posterior extension is indicated by a niche on the metalophid between the metaconid and protoconid. The other Eocene horses differ little from the condition seen in *Eohippus*. *Mesohippus* and *Miohippus* differ by a greater depth in the metaflexid groove. In *Anchitherium*, *Hypohippus*, and *Megahippus* this is a wide spatulate area, but in *Archaeohippus* an anterior extension of the metaconid restricts the lingual opening and thus an interior expansion is more apparent than real. The labial opening becomes restricted even more in the hyposodont forms.

The entoflexid enters between the entoconid and metastylid. Along the median line of the tooth it extends both anteriorly and posteriorly. This median area is nearly enclosed by an anterior expansion of the metastylid. The entoflexid is bordered by the entoconid, hypolophid, hypoconid, metalophid, and metastylid, and is roughly T-shaped. Its development through the different genera parallels that of the metaflexid. Both areas, of course, are filled with cement in the hypsodont horses.

The enamel borders of these inflections are simple in the hyracotheres but in *Miohippus*, *Archaeohippus*, and *Parahippus* there is a ridge or plication of enamel on the inner border of each inflection. In *Merychippus* and the later related genera other plications appear. Directly opposite the lingual opening of the metaflexid there is an evagination of enamel that is present in nearly all hypsodont horse teeth. It is especially conspicuous in *Pliohippus* and closely related forms and gives the metaflexid a decided boot-shape, the evagination being the heel of the boot. In the hipparions and hipparion-like horses additional plications along the metaflexid and entoflexid are common but not so common in *Pliohippus* and *Equus*. In all horses these flexids become simpler and smaller toward the base of the teeth.

The other inflections on lower teeth are much less conspicuous and usually shallow. They occur between the metaconid-metastylid, entoconid-hypoconulid, hypoconulid-hypoconid, protoconid-hypoconid and protoconid-parastylid. The most important of these is that between the metaconid-metastylid and protoconid-hypoconid. The first was discussed under the subheading metaconid-metastylid.

The inflection between the protoconid and hypoconid is deeper in the molars

than in the premolars at the same stage of wear. In the premolars of some late Miocene merychippines and in *Pliohippus* this inflection appears deep in little worn teeth but careful inspection reveals that this is only a depression from above. Additional wear, however, reveals its true depth. This inflection differs from most inflections in that it becomes shallower instead of deeper in later stages of wear.

Protostylid.—Some confusion has arisen in use of the terms protostylid and ectostylid. Osborn (1907 p. 177, fig. 164 E-F) labeled both the external column, developed from the cingulum, and the external hypolophid fold as "protostylid." Then in his memoir on the Equidae (1918 p. 8, fig. 4 a) he labeled the hypolophid fold "ectostylid", but defined the ectostylid (p. 7) as an "accessory external column between the trigonid and talonid in cleft of outer wall." At this time he did not use the term protostylid. Actually the two structures discussed here originated from different parts of the tooth although both may occur in one tooth.

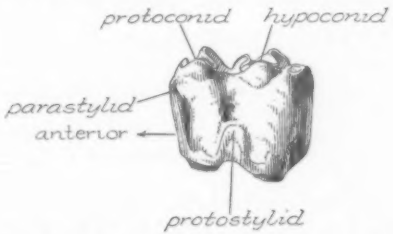

FIG. 10. *Nannippus retrusus*, Burge, Lower Pliocene, D P_4, times 1, Mus. no. 18550.

The external column (Fig. 10) is here called protostylid because it arose from the cingulum; it was the original designation by Osborn and it is less likely to be confused with the hypolophid fold that he called ectostylid.

The protostylid first appears in *Epihippus* as an incipient cusp on the labial cingulum. In this genus it occurs slightly anterior to a median position between the protoconid and hypoconid. It is still insignificant in *Mesohippus* but is a little more prominent in *Miohippus*. In the anchitherines and hypohippines it is vestigial but in some *Merychippus* teeth and also in most early and Middle Pliocene hypsodont horses it is prominent, especially in milk teeth. It sometimes is equal to one-half the length of the crown in *Merychippus* and *Hipparion* permanent teeth. Van Hoepen (1932) reports it in the genera *Notohipparion* and *Stylohipparion* from South Africa. The protostylid, however, has never been important in the Equidae.

Pli caballinid.—The name **pli caballinid** is here, for the first time, given to the external hypolophid fold, although it is not necessarily implied that this structure is a homologue of the pli caballin in upper teeth. It was called ectostylid by Osborn (1918). The pli caballinid occurs in some but not all Plio-

cene and later horses. There is a faint indication in some of the later *Merychippus* teeth and it is rare in *Pliohippus* and *Equus*. It seems to reach a maximum development in *Neohipparion eurystyle* (Cope) in which as many as four pli caballinids may occur on the antero-labial border of the hypolophid. In the specimen examined three of the folds arose independently from the hypolophid and the fourth was formed by a division of one of those present. The pli caballinid when present is pronounced in early stages of wear and either completely disappears or is greatly reduced as the tooth is worn down. Thus it is quite obvious that these plications or folds did not arise from the cingulum and are not true stylar cusps.

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GENERAL NOTES

DISTRIBUTION AND HABITAT OF SOREX LONGIROSTRIS IN NORTH CAROLINA

Since Bachman's Shrew is exceptionally rare, and its habits practically unknown, the following notes are thought worth recording.

On March 19, 1941, a few owl pellets were collected from around the base of telephone poles of the U. S. Coast Guard line at Big Kinnakeet, Hatteras Island, N. C., about 7 miles above Cape Hatteras. One of these contained fragments of a skull of *Sorex longirostris*; my identification was confirmed by H. H. T. Jackson. Subspecific determination was not possible. The nearest localities mapped in Jackson's monographic revision (N. Amer. Fauna, no. 51, 1928) are Bertie County (*longirostris*) and Chapanoke in Perquimans County (*fisheri*), each nearly 100 miles distant by airline from Big Kinnakeet. Chief interest in this record centers on its indication of the existence of an insular population. An additional recent North Carolina station for this shrew is Durham County, 6 miles east of Chapel Hill, where four young were taken alive on April 18, 1940 (wt., 2.5 grams; total length, 71 mm; tail length, 24 mm). C. S. Brimley (Jour. Elisha Mitchell Sci. Soc., Chapel Hill, N. C., Oct. 1919) notes that "the few specimens taken by me [at Raleigh, N. C.] have all been caught in traps in fields, none in woods." In decided contrast, the young shrews mentioned above were found beneath a well decayed log in an oak-pine forest, a few yards above the margin of the heavily wooded flood-plain of New Hope Creek, more than a mile from the nearest opening. The nest was simply a shallow depression lined by fragments of the leaf litter of the forest floor. Sixty traps set out during the following three nights in the immediate neighborhood failed to catch any long-tailed shrews, but took *Peromyscus nuttalli*, *P. leucopus* and *Blarina brevicauda*. Efforts to keep the young alive for study were unsuccessful. This shrew is so rare and detection of it so highly accidental (cf. Jackson, 1928, p. 86), that knowledge of its life history will likely be gained only through accumulation of such isolated observations as these.—WILLIAM L. ENGELS, *University of North Carolina, Chapel Hill.*

CROSS FOX SWIMMING

During a recent patrol trip in Mount McKinley National Park, Alaska, in November, 1940, a rare opportunity was had to observe a cross fox, *Vulpes kenaiensis*, swim the Nenana River. When the animal was first seen, he was about halfway across the stream, which is about one hundred feet wide at this point. He swam much higher out of the water than a dog would and cleverly dodged large sections of floating ice. The current is swift in the narrow channel and he took advantage of this to aid him in his crossing. Upon reaching the west bank the animal, instead of stopping to shake himself, started up the hill on a fast run. His tail had become filled with ice, the weight of which seemed to interfere with his equilibrium. Twice he almost lost control of his hind-quarters, but regained his feet each time and kept on up the hill. The east bank of the river, outside of the park boundary was carefully watched for any natural enemy that might have forced the animal into the river but apparently the fox had plunged into the icy water of his own free will.—RAYMOND W. MCINTYRE, *National Park Service, McKinley National Park, Alaska.*

A RECORD OF THE LONG-SNOUTED DOLPHIN, STENELLA PLAGIODON (COPE), FROM THE TEXAS COAST

Several weeks ago the writer received a letter from Dr. Remington Kellogg, containing the information that the Guiana River Dolphin, *Sotalia guianensis*, had been reported from Florida and suggesting that possibly it also occurred along the Texas Coast.

On January 3, 1941, I came across a porpoise skull in the taxidermy shop of Roberts and Brundrett at Port Aransas, Texas, which was visibly different from that of the common Bottle-nosed Dolphin, and which I suspected was *Sotalia*. According to the taxidermists the animal had been harpooned during the summer of 1940 in the channel (bay water) in front of Port Aransas. It was five feet long and was a solid greyish-black on top and lighter underneath. It was thought by them to be a young specimen of the common porpoise (the Bottle-nosed Dolphin).

I borrowed the skull and shipped it to Dr. Kellogg at the U. S. National Museum. He has just informed me that it agrees in all essential details with the Long-snouted Dolphin, *Stenella plagiodon* (Cope). He further says the range for this porpoise is now extended westward from Hatteras, North Carolina, to Port Aransas, Texas. However, he states that the U. S. National Museum has a skull from the Gulf Coast of Florida. Apparently then, this record is the first from the Texas Coast and extends the known range of the species westward from Florida.

This skull has been deposited with the Texas Cooperative Wildlife Collection at the Texas Agricultural and Mechanical College, College Station, Texas. The measurements made by Dr. Kellogg, which he has kindly permitted me to use here, are: Number of teeth and length of tooth row, $\frac{\text{R.33 (218 mm)} = \text{L 33 (218 mm)}}{\text{R.33 (206.5 mm)} = \text{L 32 (210.3 mm)}}$; length of rostrum, 260 mm; height of braincase, 110.5 mm; supraorbital width, 177 mm; condylobasal length, 412 mm plus (both condyles sawed off; when complete at least 15 mm longer); zygomatic width, 194.3 mm; length of braincase, 168 mm.

Grown specimens of *Stenella plagiodon* have whitish spots on the purplish grey back. A spotted porpoise is sometimes seen in offshore Gulf waters, but, if my memory serves correctly, these are much larger than the approximate seven-foot upper size limit given for the long-snouted dolphin by Kellogg (National Geographic Magazine, vol. 67, no. 1, p. 85, January, 1940). Future observation should determine whether the spotted offshore porpoise is *S. plagiodon* or some other species.—Gordon Gunter, *Game, Fish and Oyster Commission, Rockport, Texas.*

TRANSPLANTED ELK WANDERS

In a letter under date January 6, 1941, to the U. S. Fish and Wildlife Service, J. D. Findlay of the North Carolina State Division of Game and Inland Fisheries, Raleigh, North Carolina, reports the shooting of a "cow moose" in Greene County, North Carolina, bearing tag "U. S. B. S. 223." Search of the records of ear-tags placed by the U. S. Fish and Wildlife Service shows that U. S. Biological Survey tag no. 223 was placed on a 1-year 9-month old Rocky Mountain elk (*Cervus canadensis nelsoni*) shipped with 42 other elks from Yellowstone National Park by the National Park Service on February 18, 1935, to Pearisburg, Virginia, for liberation there. Later information from Mr. Findlay (letter of Jan. 21) reveals that this elk was killed December 27, 1940, at a point approximately 4½ miles northwest of Snow Hill, and about 4 miles from Farmville, North Carolina. It is interesting to note that in a period of less than six years, this elk traveled from Giles County, Virginia, to Greene County, North Carolina, some 225 miles in direct line to the southeast.—Hartley H. T. Jackson, *U. S. Fish and Wildlife Service, Washington, D. C.*

ON THE WEIGHTS OF DALL'S SHEEP

Records of actual weights of Dall's sheep (*Ovis dalli dalli*) are extremely scarce. Charles Shelden (Forest and Stream, vol. 72, 1909, p. 173) mentions a two-year-old, 125 lb. ram killed by a lynx. He also describes an ewe that was heavier. George Shiras (Nat. Geog. Mag., vol. 23, 1912, p. 485) states that white sheep weigh between 100 and 250 lbs. It is obvious that this is only an estimate.

Ernest Thompson Seton (Lives of Game Animals, vol. 3, part 2, 1929, p. 576) says, "Rams, about 200 lbs.; ewes, about 150 lbs." In his recent paper on The Distribution and Variation in the Native Sheep of North America (Amer. Mid. Nat., vol. 24, no. 3, Nov. 1940, p. 526) Ian McTaggart Cowan quotes Seton on the weights of Dall's sheep, although he thinks 150 lbs. too high for ewes.

Recently, while a member of the Carpenter Alaskan Expedition for the Academy of Natural Sciences of Philadelphia, Mr. Harold T. Green, Curator of Exhibits, had an opportunity to weigh four white sheep rams collected for a habitat group in the Academy's North American Hall. These rams were all collected on September 4, 1940, near the headwaters of the Wood River at 148° West Longitude and 63° 50′ North Latitude in central Alaska. Shot at an altitude of 5,000 feet, they were fat and in prime condition. Each ram was weighed where it fell, on a heavy spring-scale suspended from a tripod made of saplings. The amount of blood lost through bullet wounds was negligible. The weights are as follows: No. 20717 ♂, 185 lbs.; 20718 ♂, 183 lbs.; 20719 ♂, 173 lbs.; 20720 ♂, 181 lbs.

As would be expected, no. 20719 is the youngest of the group, although they all are breeding animals. No ewes were collected by the expedition, but it is hoped that in the near future definite weights will be recorded for them also.—Frederick A. Ulmer, Jr., *Academy of Natural Sciences of Philadelphia, Philadelphia, Penna.*

A SUGGESTION FOR MINK MANAGEMENT IN TEXAS

Mink (*Mustela vison*) constitute an important part of the fur catch of Brazos County, Texas. A study was made recently on the McCullough Ranch, 10 miles east of College Station, Brazos County, of prepared bait areas as a possible census method. A place was selected where mink were known to occur and small (2½ foot square) patches of wet mud were smoothed out with a shovel. A few canned sardines were placed in the center of each area. The presence or absence of tracks and bait the following day provided a clue to mink movement.

During flood stages of the Navasota River occurring while the study was in progress (October 21, 1940, to January 11, 1941) mink were found only away from the river on the small but permanent tributary streams. Floods in this region inundate the flood plain for as much as 1½ miles in either direction from the center of the river channel. It was noted that when the river was in flood stages the mink were found on the creeks as much as 5 miles from the river. When the water level dropped the mink left the small streams altogether and were again found on the main river.

The observations indicate a concentration of mink on the 6.5 miles of small streams on this 2,500-acre ranch that is not present when the river is not in flood. Trapping records for this county show that most of the mink are caught on the small streams. If further studies are made correlating actual date of trapping with the stage of the river and these prove that the above concentrations occur generally, it may be possible to manage this valuable furbearer locally on more of a sustained yield basis.

With cooperation from a few key landowners and warden patrol of previously selected areas during winter flood stages of the major rivers it would be a relatively simple matter to protect these animals when they are concentrated on favored small streams.—Arthur F. Halloran, *Texas Cooperative Wildlife Research Unit, College Station, Texas.*

THE ACADIAN BAT IN NEW JERSEY

Miller and Allen (Bull. U. S. Nat. Mus., no. 144, 1928, pp. 106–107) in their treatment of the bats of the genera *Myotis* and *Pizonyx* do not cite specimens of the eastern long-eared bat, *Myotis keenii septentrionalis* (Trouessart) from New Jersey. We have col-

lected specimens of this bat in New Jersey and investigated localities and records of the species in the state so that we may now present data on its occurrence.

Probably the first record for *M. k. septentrionalis* in New Jersey is that of C. C. Abbott, who in his "Catalogue of vertebrate animals of New Jersey" (Appendix E, Geol. N. J., 1868, p. 751) regarded this (under the name *M. subulatus* H. Allen and other authors, not Say) as the most abundant of all the species in the state, although he probably confused it, at least in part, with the common *M. lucifugus*. Stone (Ann. Rept. N. J. State Mus., pt. 2, 1908, p. 95) points out that "there is, however, no definite record."

The first actual specimen from the state is one in the American Museum of Natural History (no. 91071) taken at Palisade Park, Bergen County, by G. G. Goodwin on April 18, 1925, and mentioned by him in "The mammals of Connecticut" (Conn. State Geol. and Nat. Hist. Sur., Bull. 53, 1935, p. 46). Also in the American Museum are three alcoholic specimens of this species (nos. 91692–4) taken by G. K. Noble at Lakehurst, Ocean County, in August 1930. At Pepack, Somerset County, one of us took several *Myotis* in a small cave on March 15, 1939. Of these, one proved to be *M. k. septentrionalis*. On November 11, 1939, one of us visited the tunnels of an abandoned copper mine in Pahaquarry Township, Warren County, where *M. k. septentrionalis* was observed and collected with *M. l. lucifugus*, *Pipistrellus subflavus*, and *Eptesicus f. fuscus*. *M. k. septentrionalis* was again observed at this locality on November 30, 1940, and January 2, 1941, when a count showed that this species outnumbered *M. l. lucifugus*. On December 29, 1939, we collected in the deep tunnel of the abandoned Andover Mine at Hibernia, Morris County. Here, too, we took *M. k. septentrionalis*, although there were but a few in comparison with the several thousand *M. l. lucifugus*. On January 4, 1940, Mr. Jack Staley took several *M. k. septentrionalis* in a small mine tunnel west of Wanaque Reservoir in Bergen County. Two of them are deposited, as alcoholics, in the American Museum (nos. 135932-3).

During the winter of 1940–41 additional localities for this bat were discovered. The first was an abandoned iron mine near Chester, Morris County, where it was observed and collected on November 30 and December 21, 1940, and January 2, 1941. In December 1940, Mr. William Rusling observed this species in an abandoned copper mine at Menlo Park, Middlesex County, and specimens were collected there on December 21, 1940. The small tunnel of an old mica mine between Morristown and Mendham in Morris County, visited on December 21, 1940, contained two specimens of *M. k. septentrionalis*. Two additional localities for the species were found in Warren County on January 3, 1941, in a tunnel at the old Pequest Mine, three-fourths of a mile northeast of Pequest Furnace, and the Howell Mine in the Shades of Death, Independence Township. Specimens from these various localities will be deposited at the American Museum, the Cornell University Museum, and in our private collection.

Poole (Reading Pub. Mus. Art. Gallery. Bull., no. 13, 1932, p. 18) found *M. k. septentrionalis* unaccountably scarce in a cave in southeastern Pennsylavnia during the winter, although outnumbering *M. l. lucifugus* in August and September, while Osgood (Jour. Mamm., vol. 19, no. 4, 1938, p. 436) considered that *M. k. septentrionalis* migrates south from Vermont in the fall. Our experience, in contrast, indicates that the species winters in mine tunnels and caves in New Jersey.

We wish to thank Messrs. Peter Crowe, William Rusling, Gerbert Rebell, Robert Goldfarb, Robert Goldstein and Libero Ajello, who have made various of our trips possible, or accompanied us and assisted with the work.—Harold Trapido and James Kezer, *Zoological Laboratory, Cornell University, Ithaca, New York.*

KOGIA BREVICEPS IN SOUTH CAROLINA AND NEW JERSEY

On December 2, 1938, an employee of George Vanderbilt shot and killed a small whale stranded on Debedieu Beach of Arcadia Plantation, near Georgetown, South Carolina.

Mr. Vanderbilt, a member of the Board of Trustees of the Academy of Natural Sciences of Philadelphia, writes that the whale was apparently healthy and probably pursuing a school of fish when it crossed a sandbar and was trapped in a pool by the ebbing tide. Although helpless, it was full of life and thrashed about considerably before being shot.

Realizing that it was an unusual cetacean, Mr. Vanderbilt photographed it in color and then sent the skull to the Academy where it was identified as a pigmy sperm whale (*Kogia breviceps*). Two days later he procured the rest of the skeleton and at that time was able to take the following measurements: Length of flipper, 317 millimeters; width of flipper, 139; length of dorsal fin, 355; height of dorsal fin, 178; width across flukes, 610; diameter back of dorsal fin, 685; diameter midway between dorsal fin and flipper 787.

Because of the removal of the head previously, the total length of the whale is not accurate; it is approximately eight feet. The epiphyses of the vertebrae are firmly ankylosed to the centra. This excellent skeleton, complete excepting the pelvic bones, is now no. 20,116 in the mammal collection of the Academy of Natural Sciences of Philadelphia.

Ivan R. Tomkins (Journal of Mammalogy, vol. 15, 1934, pp. 250–251) recorded a specimen of *Kogia breviceps* found stranded on the South Carolina side of the Savannah River mouth in November 1929. In the Zoological Record (vol. 71, 1934, Mam. p. 65) the locality of this specimen is erroneously stated to be in Georgia.

I am very much indebted to E. B. Chamberlain of the Charleston Museum for further records of the occurrence of the pigmy sperm whale on the coast of South Carolina. He recently has found an old label marked "S. C. Coast" and, although the specimen cannot be located, this is evidently the first record of the whale for the state. Since Tomkins' record three South Carolina specimens have been secured by the Charleston Museum and Mr. Chamberlain intends to publish his data on these in the near future. The Debedieu Beach specimen is apparently the sixth record for the state of South Carolina.

The New Jersey pigmy sperm whale was washed ashore dead at Longport, Atlantic County, March 10, 1939. It was purchased from a local resident and presented to the Academy museum by R. Dale Benson, Jr., of the Department of Fishes. The whale, a male, weighed 930 pounds and was nine feet nine and one-half inches long. Although this whale is larger than the South Carolina specimen, its vertebral epiphyses are all loose from the centra. The Longport *Kogia* is the seventh recorded from the coast of New Jersey. Its skeleton is no. 20,117 in the mammal collection of the Academy of Natural Sciences of Philadelphia.

A more detailed account of this specimen, including a description of its soft anatomy, by Dr. Robert K. Enders of Swarthmore College, is being published in one of the Academy's serials.—FREDERICK A. ULMER, JR., *Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania.*

THE OCCURRENCE OF CITELLUS RICHARDSONII (SABINE) IN THE PLEISTOCENE OF SHERIDAN COUNTY, KANSAS

A right lower jaw, No. 6115 KUMVP of *Citellus richardsonii* bearing an incisor and P_4-M_3 was collected December 27, 1940, from an Upper Pleistocene deposit in Sheridan County, Kansas. The length of the molar series is 9.4 mm; depth of ramus in front of M_3, 6.5 mm. It corresponds in all characters present with the living species. The jaw was found associated with a number of Pleistocene mollusks.

Citellus richardsonii has been previously reported from Kansas Pleistocene deposits. A left lower jaw from Finney county, (Hibbard, Trans. Kans. Acad. Sci., vol. 40, 1937) and several rami and a maxilla from Meade county (Hibbard, Trans. Kans. Acad. Sci., vol. 43, 1940).—MORTON GREEN, *Mus. Vert. Paleo., University of Kansas, Lawrence, Kansas.*

A SWIMMING HAIRY-TAILED MOLE

On October 5, 1940, P. A. Adams, A. R. Hodgdon, and the writer were canoeing down the Oyster River at Durham, N. H. At the point of land extending into the river opposite the entrance of Johnson Creek, we came upon a Hairy-tailed Mole, *Parascalops breweri* (Bachman), swimming upon the surface. It swam in small circles, riding quite high in the water, the movements made while swimming being apparently the same as in burrowing, with each pair of legs moving in unison. The animal was making little progress against the incoming tide, by which it was probably overtaken and washed well into the center of the river. The nearest point of land was fully 50 yards away. Upon examination, it was found to be a male; the skin and skull are in the possession of Mr. P. A. Adams.—LEONARD E. FOOTE, *University of New Hampshire, Durham, N. H.*

PORCUPINE IN VIRGINIA

On September 3, 1940, while still living at Amelia, Virginia, a friend told me that a colored man living in the southwestern part of Amelia County had caught a porcupine, and had it in a cage at his home. He also told me that a filling station operator at Jetersville, on the west side of Amelia County, had had a porcupine on exhibition at his place of business some time earlier.

I went to see this colored man at once, and found that he actually had a porcupine in a small cage. It appeared to be in good condition, and he said that it ate almost anything he gave it. It had been caught by his two dogs in the woods near by. I estimated the porcupine to be about 30 inches long.

Next I interviewed the Jones Brothers at Jetersville, who said that a porcupine had been given to them about December 15, 1939, by some relatives who had driven through from Albuquerque, New Mexico. It had escaped from them early in June, 1940. Thu- it appears that the "Porky" at Amelia might be this escaped animal that had been roams ing the woods for about 90 days, and in this time had moved south a distance of 6½ miles as the crow flies.

All the Jones Brothers knew about the origin of their porcupine was that the people who gave it to them said it was brought to Albuquerque "from the mountains."—JOHN B. LEWIS, *Seward Forest, Triplett, Va.*

BATS KILLED BY SEVERE STORM

An unusually severe and unseasonal snow storm swept across the northcentral states on November 11, 1940. Wildlife in general suffered a heavy mortality in many areas, and in at least one instance the storm resulted in the death of many bats.

Two miles south of the town of St. Peter, Nicollet County, Minnesota, there are seven caves excavated in the St. Peter Sandstone. These have served for many years as winter quarters for four species of bats, *Pipistrellus subflavus obscurus, Myotis keeni septentrionalis, Myotis lucifugus lucifugus*, and *Eptesicus fuscus fuscus*. Usually only the first three species mentioned are found in the caves before mid-November, and the maximum population of *Eptesicus* is not reached before late November in mild years.

These caves were visited on October 24, 1940, at which time a number of bats were banded, but only one *Eptesicus* was found. This was as expected, for the month of October had been mild with a mean temperature of 54°F., which was 5.1°F. warmer than normal; the big brown bats were still lingering outside the caves. This October was the first in eight years without a killing frost. The mean temperature for the first ten days of November was 40.5°F. November 11 brought the storm which struck about 10:30 a.m. when falling temperatures changed sleet to snow. By noon the temperature stood at 26°F., and a 42 mile wind whipped six inches of snow into drifts. During the night the temperature fell to 10°F.

Only two of the seven caves are ever used to any extent by the big brown bats, and in these hundreds of bats of this species have clustered each winter in years past. During the storm, the entrance to one of these two caves was entirely closed by drifting snow. Immediately following the storm, Mr. Charles Meyer, who operates the caves as a tourist attraction, found more than a hundred dead bats at this closed entrance. The bats evidently had been overcome by the storm while attempting to gain entrance to the snow-blocked cave. Although several other caves were open and accessible, their habit of wintering in this particular cave caused them to continue to seek an entrance until they were exhausted and fell to the snow to die.

From Mr. Meyer's description, the vast majority of dead bats were *Eptesicus fuscus fuscus*. Apparently they were caught unaware by the storm, which struck Minnesota before the date on which this species customarily returns to the caves for winter.

In the second cave, which is much used by *Eptesicus* during the winter season, there were approximately one hundred bats. In 1939 there were nearly double this number in this cave. It may well be that some of the bats that ordinarily winter there were too far afield to reach this cave. Those that did reach the cave found an open entrance.

Mr. Joseph Pettey wrote me following the storm and reported an unusual scarity of bats in the Mystery Caves that he operates at Spring Valley, Fillmore County, Minnesota. Undoubtedly the storm claimed its toll of victims there also.—G. N. Ryscaard, *Minnesota Museum of Natural History, University of Minnesota, Minneapolis, Minnesota.*

SPEED OF THE VARYING HARE

In a note on the gray fox, Cottam, (Jour. Mamm., vol. 18, pp. 240–241, 1937), remarked that the running speeds of wild mammals are infrequently recorded, and described the manner in which a speed record of the gray fox was obtained. In pursuing the animal with an automobile, a maximum speed of 26 miles an hour was attained by the fox. Cottam's account indicates that the animal was thoroughly frightened, and probably running at top speed on ideal footing.

On the night of November 28, 1940, I obtained a record of the speed of a varying hare, *Lepus americanus virginianus*, in much the same way. As I drove through the village of Gallupville, Schoharie County, New York, a varying hare suddenly appeared in the beam of the car headlights, and started running straight ahead on a highway made dangerously smooth by a coat of ice. The animal appeared almost, if not entirely white, and held its course in the road for about one half mile. Snow had blanketed the countryside for several days and low drifts along the road's edge may have influenced the hare's decision to stay on the slippery, but comparatively level highway.

When I accelerated my car from 25 to 30 miles an hour, the hare responded with a burst of speed that kept it well out in front, yet the animal seemed not fully extended, running all the while with an ease that actually may have been restraint, due to the icy road. Apparently 31 miles an hour was maximum speed for the hare on such treacherous footing; an increase of a few miles an hour soon overtook the animal, causing it to bound off the highway into a snow-covered field and disappear from the glare of the headlights. Had the footing been secure, it seems quite possible that a speed of 35 miles an hour might have been reached by the fleet-footed animal. The next day I followed the meandering trail of the hare in an effort to collect it, but without success.

A comparison of the running speed of the varying hare in this account with Cottam's record for the gray fox on excellent footing, gives the impression that, in a sprint, the hare may be much swifter than the fox. This belief can scarcely be accepted, however, until further accurate speed records for both animals can be obtained. Dr. W. J. Hamilton, Jr., of Cornell University, has kindly called my attention to higher speeds recorded for both the red and gray fox. Harold A. Morton, (Field and Stream, p. 77, October,

1932), writes that he was forced to drive 45 miles an hour to keep apace of a red fox, which upon being collected was found to be a small animal weighing only 8 pounds. R. C. Pack, (Field and Stream, p. 69, January 1933), chased an unusually large gray fox, near Etowah, Tennessee, that kept ahead of the car for about ¾ of a mile. This animal ran at a speed of 40 miles an hour for a considerable distance; when the pursuing car was accelerated to 45 miles an hour the fox was rapidly overtaken and left the road. One of these records appears to have been fairly well authenticated by a satisfactory speedometer test, taken shortly after the chase.—J. KENNETH TERRES, *Pleasant St., Ithaca, New York.*

SPARROW HAWK PREYS ON COTTONTAIL

At 10 a.m. on March 1, 1941, an adult sparrow hawk (*Falco sparverius*) was seen taking off from a close-cropped grassy area on the college campus carrying something in its talons, the weight of which was so great that the bird could barely clear the ground. After flying about 40 feet it landed, paused momentarily, and again took wing. The hawk flew approximately 60 feet before landing again. After a pause of some five seconds the bird again took off, only to drop the object it was carrying after flying about 50 feet. The prey was recovered, and was found to be a young male cottontail (*Sylvilagus floridanus*) estimated by Dr. W. B. Davis to be 2 weeks old. Although still alive, the nasal bones had been cleanly and deeply severed, seemingly by the upper mandible of the raptor, as a smaller hole was found on the right side of the facial region where the lower mandible apparently had held as the upper tore through the skin and nasal bones. No other marks were found on the body. Although the area was combed, no other rabbits were seen. The measurements of this cottontail, now in the Texas Coöperative Research Collection, were: 152-13-34-22 millimeters.—DOUGLASS H. HUBBARD, *Department of Fish and Game, Agricultural and Mechanical College of Texas, College Station, Texas.*

TWO UNUSUAL RECORDS OF MALLOPHAGA FROM BATS

So far as the writers know, there are no previous records of Mallophaga taken from bats. The following may be cases of accidental parasitism, but they are interesting for the implication that Mallophaga may occur naturally on bats.

The first specimen was collected on *Hemiderma perspicillatum aztectum* Sauss. The bat was collected at Summit, Canal Zone, on November 12, 1930, by A. L. Dunn. The louse belongs to the genus *Physconelloides* Ewing; the species probably *galapagensis* (Kell. & Kuw.). This seems to indicate association with some Passeriform or Columbiform bird, or the possibility of natural occurrence of the louse on bats.

The second specimen was collected on *Leptonycteris nivalis* Sauss. This bat was collected at Nuevo Leon, Mexico, on August 18, 1938, by H. Hoogstraal, who kindly sent the above specimen with other excellent Mallophagan material from Mexico. The louse proved to be a specimen of *Geomydoecus geomydis* (Osb.), the normal hosts of which are gophers.

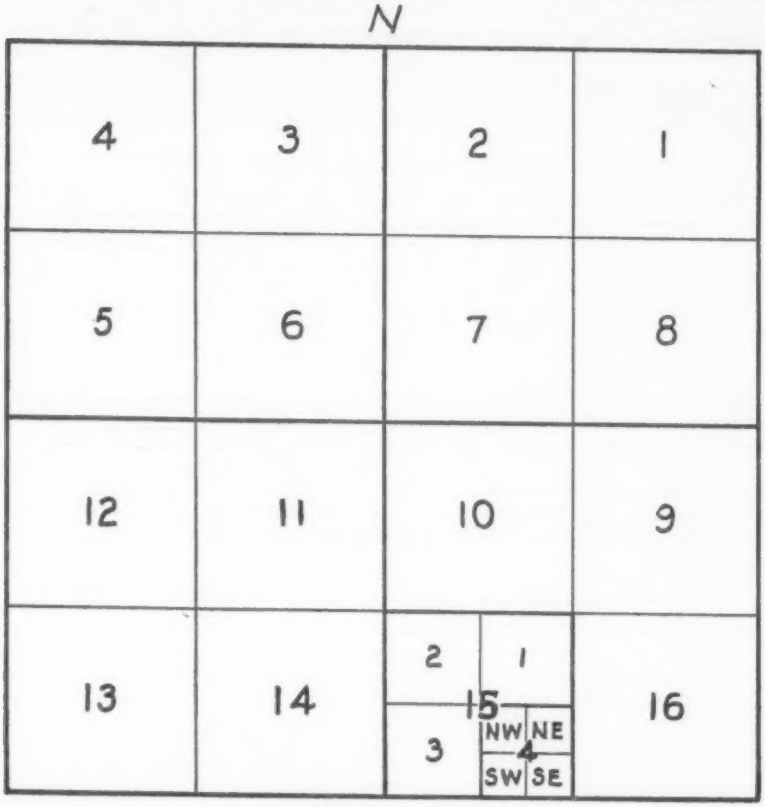
The writers believe these records are authentic but would be very much interested in any other records of biting lice from bats, which would tend to substantiate the view that bats are normal hosts of Mallophaga.—EUGENE J. GERBERG and FRANS C. GOBLE, *New York State Conservation Department, Wildlife Research Center, Delmar, New York.*

A METHOD FOR RECORDING PLACE LOCATIONS IN THE FIELD

For the past six years I have been engaged in field studies where it was necessary to record observations on various birds, mammals, and other wildlife in terms of a specific point within a section of land. Through a process of evolution a relatively simple method for doing this has been developed. It is applicable wherever section and forty lines can be discerned, and is presented here with the hope that it may be of service to

others. This system in its present form has been in use for the past two years at the Rose Lake Wildlife Experiment Station in Clinton County, Michigan. It has been found useful where a staff of field men are contributing field observations to a common file and where uniform methods of recording are necessary.

It is assumed that we know in what county and township we are working and that we need to record the section and a point within the section. In most areas some sort of



SEC. 23

map will be necessary, but if the section lines are known, the fences in an agricultural region make it possible to find many locations without a map.

A sample section of land, which has arbitrarily been numbered 23, is shown in the figure. It is divided into its 16 forties, which are numbered starting in the northeast corner in the same manner as the sections in a township. (In land recording a different numbering of the forties is sometimes used. In this case numbers 1 to 4 will be in the NE¼ of the section, 5 to 8 in the NW¼, 9 to 12 in the SW, and 13 to 16 in the SE. This method works equally well.) Any given forty can then be designated by writing two numbers, such as 23–4. This would indicate the NW¼ of the NW¼ of Section 23.

Each of the forties within the section can then be divided into four 10-acre plots numbered from 1 to 4, like forty number 15 in the figure. Then a series of three numbers will indicate any 10-acre plot within the township. As an example, 23–15–3 refers to the SW¼ of the SW¼ of the SE¼ of Section 23.

For many purposes recording to within 10 acres is sufficient. However, if a cover map is at hand and necessity requires, 2½-acre plots can easily be indicated. I have found it most convenient to go no farther with the numbering but merely to designate the four quarters of a 10-acre tract by the compass points NW, SW, SE, and NE. Thus 23–15–4 SE indicates the SE¼ of the SE¼ of the SW¼ of the SE¼ of Section 23.

The use of this method in conjunction with an aerial photograph of a study area makes it particularly easy to locate and record an observation in a minimum of time.—Durward L. Allen, *Game Division; Department of Conservation, Lansing, Michigan.*

SOME LUNGWORM RECORDS FROM FOXES IN NEW YORK

Since records of lungworms in wild foxes are rare, it seems worthwhile to report the following findings. During November and December of 1940 the carcasses of forty red foxes and twelve gray foxes were obtained through the courtesy of Mr. Ed Maunton, who traps in the Helderberg Plateau region, which comprises about five townships north of Catskill Creek in southwestern Albany County and northwestern Greene County, New York. Examination of the lower respiratory tract revealed the presence of *Eucoleus aerophilus* in the trachea and larger bronchi of 22 of the red foxes, and *Crenosoma vulpis* was found in the bronchi of 6 of the red foxes and 2 of the gray foxes. *E. aerophilus* is considered to be among the most important endoparasites of ranch foxes, sometimes causing serious losses. *C. vulpis* is a European species, so far confined to the northeast of this country. All of the animals were trapped during the above mentioned months and none was in poor condition, although Mr. Maunton reported having heard some of them coughing as he approached them. Material has been saved for histological examination. We are indebted to J. T. Lucker of the Bureau of Animal Industry for the identification of these worms.—Frans C. Goble and Arthur H. Cook, *New York State Conservation Dept., Wildlife Research Center, Delmar, New York.*

REVIEWS

Snyder, L. L., E. B. S. Lagler, T. B. Kurata, F. A. Urquhart, and J. F. Brimley. A FAUNAL INVESTIGATION OF PRINCE EDWARD COUNTY, ONTARIO. University of Toronto Studies, Biological Series, no. 48, 123 pp., 1941.

An indicated in the title, this paper is a faunistic treatise in which mammals, birds, amphibians, reptiles, spiders, crickets, grasshoppers, and long-horned beetles of Prince Edward County are discussed in a semi-popular fashion. The introduction and the section on mammals are of interest to mammalogists, for in this section of Ontario "there is a striking mixture of boreal and austral forms."

In discussing the biota of the area, the authors content themselves with the antiquated concept of Life Zones, as proposed by Merriam and his disciples, a tendency that is far too common among mammalogists. Although demonstrated time and again (Livingston and Shreve, Kendeigh, Dice, Shelford, Daubenmire) that this concept fails in explaining the dynamics of distribution, mammalogists in general tenaceously adhere to it as an *idêe fixe*. A far better concept, in the opinion of the reviewer, is that of the biome, with its subdivisions, and ecotones as proposed by Clements, Carpenter, Dice, Pitelka, and others. At least, the concept is worthy of our serious consideration.

The section on mammals treats 31 species based upon the collection of 76 specimens and field notes. The presentation is that of an annotated list with the emphasis on distribution. The sequence of species, apparently original with the authors, is unique, as follows: moles, shrews, bats, lagomorphs, rodents, carnivores, seals, artiodactyls. No mammal is identified beyond species, an unfortunate circumstance in any paper purporting to be a report on a faunal investigation.—WILLIAM B. DAVIS.

C. R. Carpenter. A FIELD STUDY IN SIAM OF THE BEHAVIOR AND SOCIAL RELATIONS OF THE GIBBON (HYLOBATES LAR). Comparative Psychology Monographs, vol. 16, no. 5, ser. no. 84, December, 1940, 212 pp. Johns Hopkins Press.

For one reason if for no other the present report is distinctive. It is not merely another item of a lengthy series, but the third and most extensive study constituting a new approach to primate knowledge initiated and developed by the author. Obviously the proper way to learn about the behavior of wild animals is to study them in the field and few mammals lend themselves so readily to intensive observation as diurnal, arboreal primates.

The present report, with an introduction by Adolph H. Schultz, is the twenty-seventh contribution resulting from the Asiatic Primate Expedition of 1937, led by Harold J. Coolidge, Jr. It embodies the intensive study in northern Siam of the behavior and social relations of *Hylobates lar*, and only incidental mention of observations on gibbons elsewhere. The author had already proved himself to be a master at this sort of intensive field observation of primates and the present report is by far the most comprehensive that is now available on the daily life of any of the anthropoid apes. In orderly array are considered individual, family and intragroup relations, diurnal cycles, territoriality, locomotion, and many other aspects of gibbon life. There are presented a sufficient number of journal quotations to be informative without being tedious, a shortcoming of many field study reports.

It is interesting to note that, unlike so many other primates, the effect of this gibbon upon man's local economic activities is practically nil, for the gibbon is not a crop raider. Evidence was secured that gibbons do feed upon the eggs and young of birds. The frequency of healed fractures in the skeleton indicates that bone breakage occurs far more often than one would expect, likely because of brachiation. Of possibly wide biological significance is the conclusion that solitary males are not necessarily senile individuals that have been driven from the company of females by more vigorous rivals, but on the contrary these males are in most instances subadult.

Studies of undisturbed wild mammals are very difficult and we need more reports of the sort that Dr. Carpenter has given us.—A. B. Howell.

NOMENCLATURE AND CORRELATION OF THE NORTH AMERICAN CONTINENTAL TERTIARY. (Report by Horace E. Wood, 2nd, Chairman, Ralph W. Chaney, John Clark, Edwin H. Colbert, Glenn L. Jepsen, John B. Reeside, Jr., and Chester Stock, Committee) Bull. Geol. Soc. Amer., vol. 52, pp. 1–48, 1 pl., 1941.

This report is a summary of the latest nomenclature and correlation of the North American continental Tertiary. It covers all known mammal-bearing formations in North America, including Mexico, Central America, and the West Indies. It also includes marine formations in which land mammals have been found, a summary of pleistocene mammalian fauna, and mention of certain upper Cretaceous records.

It is the result of three years of work on the part of the committee; the original proposal for a provincial time scale was made in 1937. Most active workers in the field were consulted either by personal visit or by mail; hence, this report as stated in the introduction "has been a cooperative venture by the entire profession."

This report is the most recent of several that have appeared, each an attempt to bring some order out of the confusion of faunal, formation, and locality names abounding in the literature. From the days of the Hayden Surveys there has been a steadily increasing number of names introduced, each attempting to be more specific, more delimiting in time or area. Subsequent workers frequently misunderstood and misused these terms, and confusion of terminology was the result. Osborn and Matthew brought some order to this nomenclature in 1909, but in the succeeding years additional names have been added. In more recent time Simpson and Stirton have published summaries in which the "faunal name" concept was introduced in contrast to names that had geologic or time meaning. Thus the Feldt Ranch fauna came from the type locality of the Ogallala formation. This formation carried at least a dozen other faunas, each with its distinctive name. This idea of a faunal name in contrast to a geologic one has gained general acceptance. In the glossary of the present paper the authors have listed and classified 349 terms under which occurrences of Cenozoic land mammals have been described. These terms have been classified as: an age (Barstovian), a series (Arikaree groups of formations), a formation (Brule), a member (the Gray Bull member of "Bighorn Wasatch"), or a local fauna (Long Island local fauna).

In addition to the above valuable list the committee has prepared a provincial time scale of some twenty names, by means of which all North American faunas may be dated. Each of these is defined in terms of its North American occurrence. Most of these names are based upon a formation whose fauna is typical of the time, and the name formed by adding "ian," or "an," or "n" for distinction. For example; Duchesnean age is the new provincial time term. It is based upon the Duchesne River formation and its well known fauna. Correlative faunas from the Sespe of California would be spoken of as Duchesnean in age. This is a similar system to that proposed by Schenck and Kelinpell for the Tertiary of the Pacific Coast. Each of the names introduced is defined, a correlative fauna name, all index fossils listed, first and last appearances of genera listed and characteristic fossils named. A correlation chart showing the provincial ages, faunal zones, North American faunas and the European ages is included in the report. It is difficult to imagine other information that the authors might have included. One wishes that there was a detailed monograph of each fauna, typical of the provincial time term chosen, but perhaps this will come in the future. That overlapping faunas will be found no one will question, and that the list must be revised and amended in the future goes without saying. However, this summary certainly provides an excellent foundation for present work and will eliminate a vast amount of confusion if followed by contemporary workers.—CURTIS HESSE.

RECENT LITERATURE

[Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters]

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——— Rare monkeys. Zoonooz, San Diego, vol. 12, no. 11, pp. 1–5. November, 1940. (Photographs of five monkeys, those of the black Celebes macaque and Bornean orang being especially noteworthy.)

——— Animals and air raids. Conservation, Washington, D. C., vol. 6, no. 6, p. 19. November-December, 1940.

——— A letter from a reader of Zoonooz. Zoonooz, San Diego, vol. 12, no. 12, pp. 4–5. December, 1940. (Good photograph of giant anteater.)

——— Carrying on at the zoo. Zoonooz, San Diego, vol. 12, no. 12, pp. 5–6. December, 1940. (Lesser panda.)

——— Recent additions to British Mammals. Nature, London, vol. 147, no. 3716, p. 83. January 18, 1941. (Edible dormouse, squirrel-tailed dormouse, small Japanese deer, 'wild' goats.)

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——— Mammals and man. Nature, London, vol. 147, no. 3721, p. 236. February 22, 1941.

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COMMENTS AND NEWS

CONVENTION ON NATURE PROTECTION AND WILD LIFE PRESERVATION IN THE WESTERN HEMISPHERE

The present Convention on Nature Protection and Wild Life Preservation was opened for signature to the governments of the American Republics at the Pan American Union, Washington, D. C., on October 12, 1940, on which date plenipotentiaries of the following countries affixed their signatures: Cuba, Ecuador, El Salvador, the United States, Nicaragua, Perú, the Dominican Republic and Venezuela. To February 25, 1941, the following additional countries had signed the Convention: Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, and Uruguay. Other countries have signified their intention of signing in the near future.

Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere

PREAMBLE

The governments of the American Republics, wishing to protect and preserve in their natural habitat representatives of all species and genera of their native flora and fauna, including migratory birds, in sufficient numbers and over areas extensive enough to assure them from becoming extinct through any agency within man's control; and

Wishing to protect and preserve scenery of extraordinary beauty, unusual and striking geologic formations, regions and natural objects of aesthetic, historic or scientific value, and areas characterized by primitive conditions in those cases covered by this Convention; and

Wishing to conclude a Convention on the protection of nature and the preservation of flora and fauna to effectuate the foregoing purposes, have agreed upon the following Articles:

ARTICLE I

Description of terms used in the wording of this Convention.

1. The expression *National Parks* shall denote areas established for the protection and preservation of superlative scenery, flora and fauna of national significance which the general public may enjoy and from which it may benefit when placed under public control.

2. The expression *National Reserves* shall denote regions established for conservation and utilization of natural resources under government control, on which protection of animal and plant life will be afforded in so far as this may be consistent with the primary purposes of such reserves.

3. The expression *Nature Monuments* shall denote regions, objects, or living species of flora or fauna of aesthetic, historic or scientific interest to which strict protection is given. The purpose of nature monuments is the protection of a specific object, or a species of flora or fauna, by setting aside an area, an object, or a single species, as an inviolate nature monument, except for duly authorized scientific investigations or government inspection.

4. The expression *Strict Wilderness Reserves* shall denote a region under public control characterized by primitive conditions of flora, fauna, transportation and habitation wherein there is no provision for the passage of motorized transportation and all commercial developments are excluded.

5. The expression *Migratory Birds* shall denote birds of those species, all or some of whose individual members, may at any season cross any of the boundaries between the American countries. Some of the species of the following families are examples of birds characterized as migratory: Charadriidae, Scolopacidae, Caprimulgidae, Hirundinidae.

ARTICLE II

1. The Contracting Governments will explore at once the possibility of establishing in their territories national parks, national reserves, nature monuments, and strict wilderness reserves as defined in the preceding article. In all cases where such establishment is feasible, the creation thereof shall be begun as soon as possible after the effective date of the present Convention.

2. If in any country the establishment of national parks, national reserves, nature monuments, or strict wilderness reserves is found to be impractical at present, suitable areas, objects or living species of fauna or flora, as the case may be, shall be selected as early as possible to be transformed into national parks, national reserves, nature monuments or strict wilderness reserves as soon as, in the opinion of the authorities concerned, circumstances will permit.

3. The Contracting Governments shall notify the Pan American Union of the establishment of any national parks, national reserves, nature monuments, or strict wilderness reserves, and of the legislation, including the methods of administrative control, adopted in connection therewith.

ARTICLE III

The Contracting Governments agree that the boundaries of national parks shall not be altered, or any portion thereof be capable of alienation, except by the competent legislative authority. The resources of these reserves shall not be subject to exploitation for commercial profit.

The Contracting Governments agree to prohibit hunting, killing and capturing of members of the fauna and destruction or collection of representatives of the flora in national parks except by or under the direction or control of the park authorities, or for duly authorized scientific investigations.

The Contracting Governments further agree to provide facilities for public recreation and education in national parks consistent with the purposes of this Convention.

ARTICLE IV

The Contracting Governments agree to maintain the strict wilderness reserves inviolate, as far as practicable, except for duly authorized scientific investigations or government inspection, or such uses as are consistent with the purposes for which the area was established.

ARTICLE V

1. The Contracting Governments agree to adopt, or to propose such adoption to their respective appropriate law-making bodies, suitable laws and regulations for the protection and preservation of flora and fauna within their national boundaries, but not included in the national parks, national reserves, nature monuments, or strict wilderness reserves referred to in ARTICLE II hereof. Such regulations shall contain proper provisions for the taking of specimens of flora and fauna for scientific study and investigation by properly accredited individuals and agencies.

2. The Contracting Governments agree to adopt, or to recommend that their respective legislatures adopt, laws which will assure the protection and preservation of the natural scenery, striking geological formations, and regions and natural objects of aesthetic interest or historic or scientific value.

ARTICLE VI

The Contracting Governments agree to cooperate among themselves in promoting the objectives of the present Convention. To this end they will lend proper assistance,

consistent with national laws, to scientists of the American Republics engaged in research and field study; they may, when circumstances warrant, enter into agreements with one another or with scientific institutions of the Americas in order to increase the effectiveness of this collaboration; and they shall make available to all the American Republics equally through publication or otherwise the scientific knowledge resulting from such cooperative effort.

ARTICLE VII

The Contracting Governments shall adopt appropriate measures for the protection of migratory birds of economic or aesthetic value or to prevent the threatened extinction of any given species. Adequate measures shall be adopted which will permit, in so far as the respective governments may see fit, a rational utilization of migratory birds for the purpose of sports as well as for food, commerce, and industry, and for scientific study and investigation.

ARTICLE VIII

The protection of the species mentioned in the Annex to the present Convention, is declared to be of special urgency and importance. Species included therein shall be protected as completely as possible, and their hunting, killing, capturing, or taking, shall be allowed only with the permission of the appropriate government authorities in the country. Such permission shall be granted only under special circumstances, in order to further scientific purposes, or when essential for the administration of the area in which the animal or plant is found.

ARTICLE IX

Each Contracting Government shall take the necessary measures to control and regulate the importation, exportation and transit of protected fauna or flora or any part thereof by the following means:

1. The issuing of certificates authorizing the exportation or transit of protected species of flora or fauna, or parts thereof.

2. The prohibition of the importation of any species of fauna or flora or any part thereof protected by the country of origin unless accompanied by a certificate of lawful exportation as provided for in Paragraph I of this article.

ARTICLE X

1. The terms of this Convention shall in no way be interpreted as replacing international agreements previously entered into by one or more of the High Contracting Powers.

2. The Pan American Union shall notify the Contracting Parties of any information relevant to the purposes of the present Convention communicated to it by any national museums or by any organizations, national or international, established within their jurisdiction and interested in the purposes of the Convention.

ARTICLE XI

1. The original of the present Convention in Spanish, English, Portuguese and French shall be deposited with the Pan American Union and opened for signature by the American Governments on October 12, 1940.

2. The present Convention shall remain open for signature by the American Governments. The instruments of ratification shall be deposited with the Pan American Union, which shall notify their receipt and the dates thereof, and the terms of any accompanying declarations or reservations, to all participating Governments.

3. The present Convention shall come into force three months after the deposit of not less than five ratifications with the Pan American Union.

4. Any ratification received after the date of the entry into force of the Convention, shall take effect three months after the date of its deposit with the Pan American Union.

ARTICLE XII

1. Any Contracting Government may at any time denounce the present Convention by a notification in writing addressed to the Pan American Union. Such denunciation shall take effect one year after the date of the receipt of the notification by the Pan American Union, provided, however, that no denunciation shall take effect until the expiration of five years from the date of the entry into force of this Convention.

2. If, as the result of simultaneous or successive denunciations, the number of Contracting Governments is reduced to less than three, the Convention shall cease to be in force from the date on which the last of such denunciations takes effect in accordance with the provisions of the preceding Paragraph.

3. The Pan American Union shall notify all of the American Governments of any denunciations and the date on which they take effect.

4. Should the Convention cease to be in force under the provisions of Paragraph 2 of this article, the Pan American Union shall notify all of the American Governments, indicating the date on which this will become effective.

REPRINTS OF RECENT LITERATURE

Reprints of the Recent Literature section are now being printed on one side of the page to facilitate bibliographical filing. The cost is somewhat higher than previous prices. Address inquiries to Miss Viola S. Schantz, U. S. Fish and Wildlife Service, Washington, D.C.

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